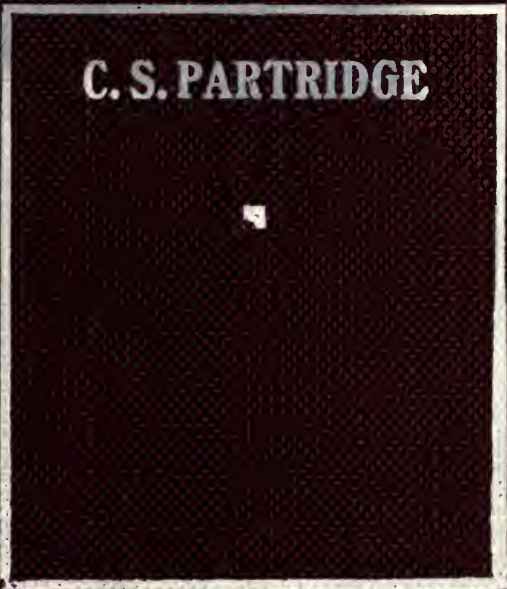


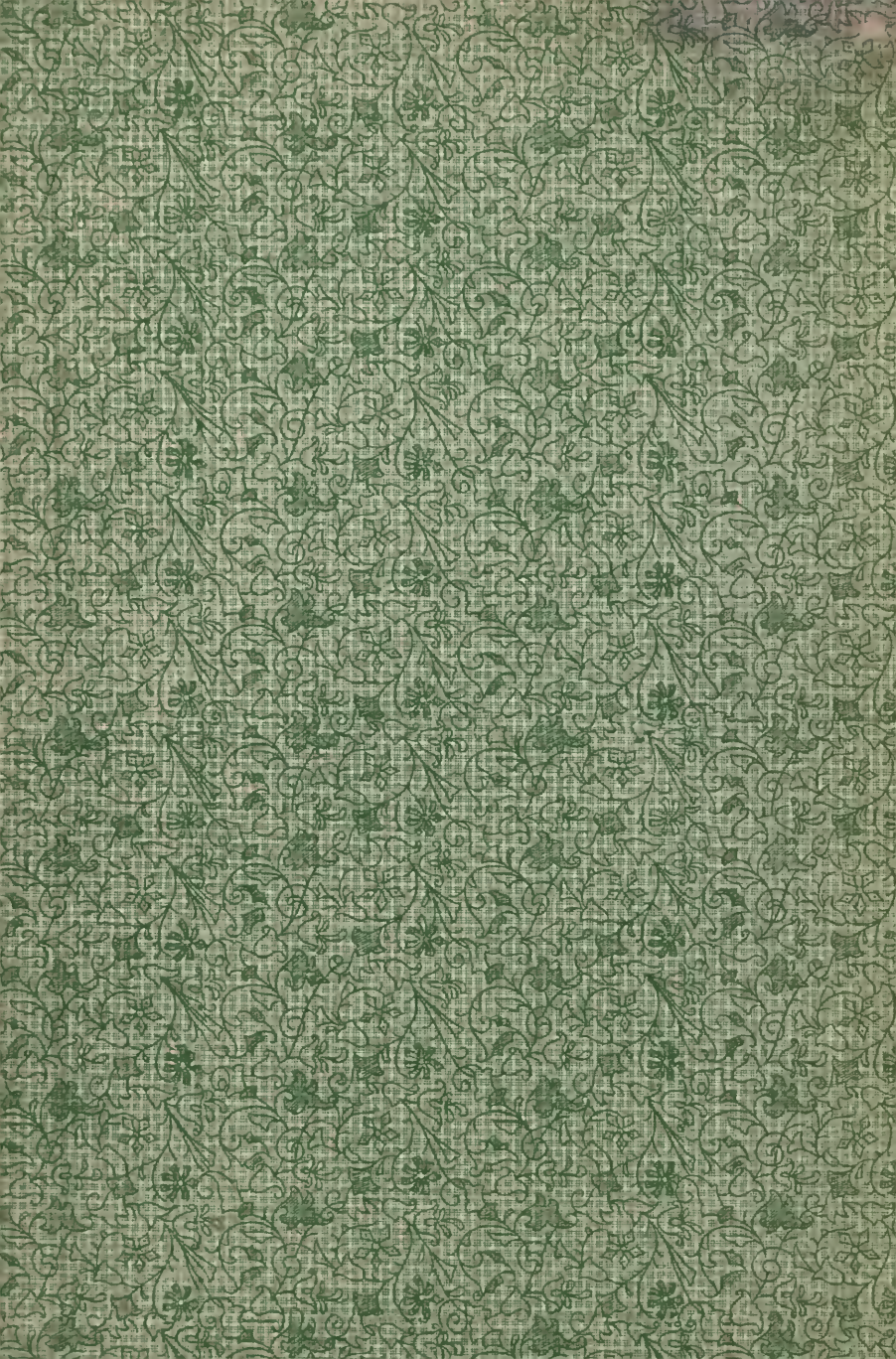


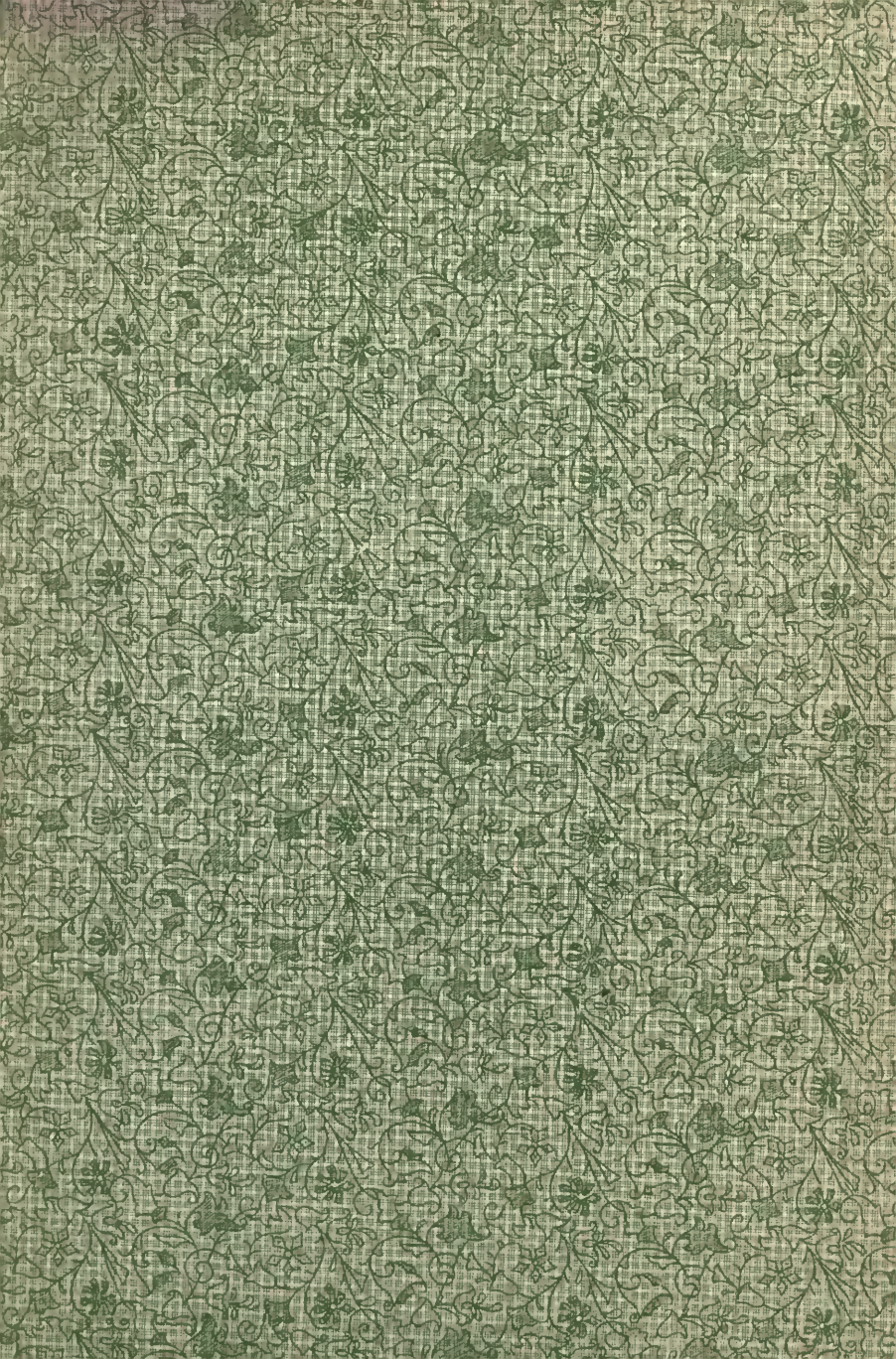
# ELECTROTYPING

C. S. PARTRIDGE



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# ELECTROTYPING

A PRACTICAL TREATISE ON THE ART OF ELECTROTYPING BY THE LATEST KNOWN METHODS.

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CONTAINING HISTORICAL REVIEW OF THE SUBJECT, FULL DESCRIPTION OF THE TOOLS AND MACHINERY REQUIRED, AND COMPLETE INSTRUCTIONS FOR OPERATING AN ELECTROTYPING PLANT.

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BY C. S. PARTRIDGE.

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*SECOND EDITION.*

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THE INLAND PRINTER COMPANY.

1908.

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## PREFACE TO FIRST EDITION.

THE art of electrotyping has within recent years made material advancement. Labor-saving machinery and appliances have simplified and at the same time insured greater accuracy in the mechanical features of the art, while the constant and increasing demand for rapid work has been an incentive to invention and research, with the result that electrotypes are now produced in much less time than was formerly required. That the literature of electrotyping, although of great value, is hardly up to date, is evidenced by the statements of Urquhart, Wilson, Langbein and others, to the effect that from seven to twenty hours are required to deposit shells of practical thickness. While these statements were, perhaps, correct at the time they were published, they can hardly be considered accurate now, in view of the fact that the plate from which this page is printed was deposited in fifteen minutes.

In the following pages, revised from a series of articles in *The Inland Printer*, I have endeavored to describe, as clearly and simply as possible, the most approved methods of producing electrotypes, with the hope that the information may prove of value both to the professional and the amateur.

C. S. PARTRIDGE.

CHICAGO, June, 1899.

## PREFACE TO SECOND EDITION.

THE general favor accorded "Electrotyping" made several printings of the first edition necessary. This second edition has been revised and corrected to date and much new matter added, an important addition being a glossary or reference list of terms, processes and apparatus.

C. S. PARTRIDGE.

CHICAGO, December, 1908.

# CONTENTS.

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| CHAPTER                                                         | PAGE |
|-----------------------------------------------------------------|------|
| I. HISTORICAL REVIEW . . . . .                                  | 7    |
| II. THE BATTERY . . . . .                                       | 18   |
| III. THE DYNAMO . . . . .                                       | 25   |
| IV. THE BATH . . . . .                                          | 35   |
| V. STEEL, BRASS AND NICKEL BATHS . . . . .                      | 41   |
| VI. MANAGEMENT OF BATHS . . . . .                               | 46   |
| VII. AGITATION OF BATHS . . . . .                               | 51   |
| VIII. MEASURING INSTRUMENTS . . . . .                           | 58   |
| IX. PREPARATION OF WORK . . . . .                               | 63   |
| X. MOLDING . . . . .                                            | 67   |
| XI. BUILDING . . . . .                                          | 78   |
| XII. METALLIZING . . . . .                                      | 83   |
| XIII. THE CONDUCTORS . . . . .                                  | 94   |
| XIV. DEPOSITING . . . . .                                       | 99   |
| XV. CASTING . . . . .                                           | 105  |
| XVI. FINISHING . . . . .                                        | 119  |
| XVII. TRIMMING AND ROUTING . . . . .                            | 127  |
| XVIII. REVISING . . . . .                                       | 136  |
| XIX. BLOCKING . . . . .                                         | 143  |
| XX. DR. ALBERT'S METAL MOLDS . . . . .                          | 150  |
| REFERENCE LIST OF TERMS, PROCESSES AND APPA-<br>RATUS . . . . . | 161  |



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# ELECTROTYPING.

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## CHAPTER I.

### HISTORICAL REVIEW.

DURING the period of 1837-1839, Professor Jacobi, of St. Petersburg, Mr. Thomas Spencer, of Liverpool, and Mr. C. J. Jordan, of London, made at different times announcement of their independent discovery of the art of electrotyping. According to one authority the rival claims of Professor Jacobi and Mr. Spencer were presented by them in person before the Chemical Section of the British Association for the promotion of Science, and this august assembly after prolonged discussion decided that both had independently arrived at the same result, but that the priority of discovery was undoubtedly Mr. Spencer's. However, this decision of the society with the high-sounding title did not by any means settle the controversy, which became still further complicated by the later claims of Mr. Jordan. In view of the conflicting character of the evidence we are inclined to divide the honor between the gentlemen named; but whatever merit may attach to their respective claims as discoverers, there is probably no question but that the credit for the first practical application of the new art to the printing business belongs to an Amer-

ican — Mr. J. A. Adams, of New York, who produced successful electrotypes of wood engravings in 1841. It is to American inventive genius, also, that we are indebted for most of the labor-saving methods and machinery which have brought the art to its present state of perfection. In England, electrotyping seems to have been first utilized chiefly for the production of metallic art work such as engraved medals, statuary, etc. Messrs. Elkington & Co. were so successful in this branch of the art that in 1845 they had established a considerable business in the duplication of cups, vases and other articles, deposited entirely in gold, silver and copper. While our friends over the water have perhaps excelled in this feature of electrotyping, Americans were quick to grasp and develop the possibilities of the art as applied to printing purposes. In 1863, Mr. William Filmer, an electrotyper of New York, who had much to do with the early development of electrotyping, after an extended trip abroad stated that electrotyping as applied to the printing industry was generally recognized in Europe as an American art.

The discovery of electrotyping, like many other important discoveries, was purely accidental. Mr. Spencer, for instance, was trying some experiments in electro-chemistry. He had immersed a copper plate in a solution of sulphate of copper and a zinc plate in a solution of common salt, connecting them together by a wire, and separating the fluids by a partition of plaster of paris. In order that no action should take place on the wire connecting the plates, he covered it with sealing wax, and in so doing, spilled some of the wax on the copper plate. After a few days he found

that copper crystals had covered the copper electrode except the portion protected by the drops of wax. It at once occurred to him that by the application of wax or other non-conducting substance, he could perfectly control the deposition of the metal. Mr. Spencer then coated a plate of copper with beeswax, and scratched his name through the wax on the plate and connected it with a zinc plate of corresponding size, immersing them in the solutions as before. After a few hours he found, as he expected, that the portion of the plate from which the wax had been removed was coated with bright metal, while the protected portions remained untouched.

The discovery of electrotyping created hardly less interest than the nearly contemporaneous invention of the electric telegraph. Scientists, professional men and workmen became alike interested, and the copying of medals, coins, etc., by electrotyping became a popular amusement of the time.

The apparatus employed at this time consisted of a single cell, as before described. The back of the coin or medal to be copied was first coated with wax or varnish. Copper was then deposited on its face to form a matrix, which, after having been removed from the coin and properly prepared, was returned to the bath to receive in its turn a deposit of copper in the form of a facsimile of the original.

In 1840, Mr. Joseph Murray discovered that non-conductive substances could be made conductive by applying to them a film of graphite. This was a notable step in the progress of the art, for it not only made possible the duplication of nonmetallic objects, but opened the way for the use of gutta-percha, wax and

similar substances for molding material in which an impression of the coin or other object could be made, thereby greatly expediting the work by saving the time required to make a matrix in copper.

The invention of the separate battery about the same time, by Mr. Mason, marked another material advancement in the art.

Mr. Adams made his first electrotype copies of wood engravings by depositing copper directly on the engraving and using the deposit for a matrix. The process was, of course, very crude and invariably destroyed the wood engraving, but it was of value as an insurance against checking and because the electrotype would stand much more wear than the wood cut.

Mr. J. W. Wilcox, of Boston, Massachusetts, an employee of Mr. Daniel Davis, was the originator of the methods by which electrotyping was made of practical use for the printing business. Mr. Davis had produced a few electrotypes, but after the method laid down by European experimenters; and it may be that Mr. Wilcox obtained, through his connection with Mr. Davis, his first information of the possibility of making duplicates by galvanoplasty, yet Mr. Davis did not encourage, but, on the contrary, endeavored to dissuade Mr. Wilcox from the notion that something, in a business way, could be gotten out of the new art. Mr. Wilcox had so much faith in a successful result that he resigned his position, that of foreman for Mr. Davis, engaged a room and devoted his energies to the work. In less than one month thereafter he produced electrotypes from cuts and type, without injury to the originals, by virtually the same manipulation that is

now used. His most important discovery was of a wax composition in which molds could be readily made by pressure. He immediately started in the business of making plates for printers' use, and was the first to make a business of electrotyping. He showed specimens of electrotypes in the fifth exhibition of the Massachusetts Charitable Mechanic Association (1847), and page 42 of the report for that year reads as follows:

2. J. W. Wilcox, Boston. Specimens of Electrottype. These specimens are produced, as we think, in a manner original with Mr. Wilcox. The originality consists in making the matrix, upon which the copper is deposited, of wax, either coated or mingled with plumbago. Previously, matrices were usually made of soft metal upon which, in a melted state, the original plate was laid and subjected to a smart blow, when the melted metal was partially hardened in the process of cooling. Objections to this mode are: liability of injuring molds or plates made of soft materials and, of course, its inapplicability to wood engravings, and the difficulty of obtaining perfect matrices, since even a small portion of air beneath the plate might, when the blow is given, materially injure the cast. Besides, the old mode is hardly practicable, when the plate is of great extent. By the method of Mr. Wilcox, matrices of any dimensions can be made from a plate or mold of any materials without the least injury to the original; and the liability of failing to obtain a good matrix is almost wholly obviated.

We hence infer that, among other benefits resulting from this process, it will be found more economical, and will contribute much to the beauty and perfection of the impression, to use copper plates made from the blocks for wood engravings, than to use the blocks themselves. Indeed, several of the specimens exhibited were of this kind, and impressions from them substantiate the opinion of the committee.

One of the specimens examined was a copper stereotype

plate for common printing, accompanied by an impression from the plate. This suggests to the committee what they consider the most important feature of the subject, namely, the probability that copper stereotype plates will take the place of common type-metal plates. The circumstances to warrant this probability are, the greater durability of copper plates and the more perfect outline of the letters. That copper plates will be more durable does not admit of a doubt; and some practical men express their belief that they will last six times as long as type-metal plates. If so, and if, as is almost certain, copper is soon to become much cheaper than at present, there will be a decided economy in using copper plates, and the use of them will contribute very materially to the diffusion of knowledge, and, as we trust, to the growth of virtue. In addition to this, the impression from such a plate will be much more distinct and beautiful, inasmuch as a mold in wax will have its lines better defined than a similar mold in plaster.—Gold Medal.

Mr. Davis had an exhibit of magnetical apparatus in the same class and year, for which he was awarded a gold medal, and it is not likely that the award to Mr. Wilcox would have passed unchallenged if not properly made.

Mr. Wilcox continued in business many years to his profit, but did not derive as much financial benefit from his inventions as he might had he patented them. He died in West Roxbury, Massachusetts, February 19, 1876.

The following, from a letter recently received from Mrs. Wilcox in reply to an inquiry regarding her husband, shows that Mr. Wilcox did not confine his efforts entirely to making printers' plates:

He perfected the art so well that the Massachusetts Charitable Mechanic Association, in 1847, awarded him a gold medal for specimen of electrotypes. The American

Institute of New York awarded him a medal in 1848. He turned his attention to making clock dials and steam-gauge dials and all kinds of ornamental plates for decorating soda fountains and other ornamental work. He invented a process of electrotyping the face of rolls for dressing cloth, and received a medal in 1860 from the Massachusetts Charitable Mechanic Association for the same.

Mr. Daniel Davis — properly Daniel Davis, Jr. — was a prominent manufacturer of philosophical instruments, in Boston. In 1842 he published “Davis’ Manual of Magnetism,” in which the process of electro-metallurgy was mentioned, and there appeared a cut and an electrotype duplicate of the same. In the sixth edition, published in 1847, there is a frontispiece — two pages — one of which was printed from an original engraving, on copper, and the other from an electrotype duplicate made by depositing on the original for a matrix, and by depositing on the matrix to make the plate printed from. At the bottom of the page it is stated that that duplicate was made by Mr. Davis. Page 53 of that edition was printed from an electrotype made by Mr. Wilcox. The seventh edition of Davis’ Manual, issued in 1848, contains the following regarding the electrotype process :

An engraved copper plate may be copied by taking an impression on clean and bright sheet lead with a powerful press, or if the plate is small it may be pressed by hand on the melted fusible metal. Or a mold may be made by depositing copper on the plate itself, but care must be taken to prevent adhesion both of the mold to the original and of the copy to the mold. The duplicate thus obtained will furnish engravings which can not be distinguished from those printed from the original plate, however elaborate the design and delicate the workmanship may be.

An engraving printed from an electrotype plate by this method is given as a frontispiece to the 1842 manual.

A medal or engraved plate is placed in the solution and copper deposited upon it. The negative wire of the battery should be connected with the rim of the medal, and in case of an engraved plate it may be soldered to the corners. The deposit is apt to adhere very firmly, sometimes so much so that its removal is impossible. This may be avoided by slightly greasing or oiling the mold and then brushing it over with a little dry copper bronze.

The mold thus obtained may have a wire soldered to it and be placed in the solution like the original one. In most cases it will be considered safer to take a mold of a valuable medal or plate in soft wax or by some of the other processes to be described. An engraving printed from an electrotype plate obtained by this process is given as a specimen in the 1847 manual.

In the same edition there is the following notice :

This book is believed to be the first ever electro-stereotyped throughout. A single page (the 53d) of "Davis' Manual of Magnetism," published in August, 1847, was previously electrotyped by the subscriber in the same manner. The advantages of this process are: First, its durability, the copper face of the type and illustrations lasting many times longer than the type-metal; and second, the blackness of the impression taken from copper.

I am prepared to execute any orders for printed work in the above style, of which the present book is an example, and to execute any number of facsimiles of engraved copper plates and of whatever size. The face of each electrotype copy is harder and more durable than the rolled copper.

I am also prepared to execute plates of electrotype copper for engraving of greater purity and uniformity than can otherwise be prepared.

I have, within two years, electrotyped a large number of wood cuts, many of which have been in constant use and

which have answered every expectation as to their durability and the perfect character of the impression.

The report of the Massachusetts Charitable Mechanic Association, taking the lowest estimate, assigns to these a durability six times greater than that of the type-metal stereotypes. The slight additional expense of the electro-stereotypes is therefore in no proportion to their comparative value.

Ornamental work and every branch of the art of electrotyping will receive the attention of the subscriber.

J. W. WILCOX.

In 1853, an improvement in the Smee battery was suggested by Mr. Adams, and immediately adopted by electrotypers in America and Europe. Other improvements of a more or less important nature were made by Mr. Adams, Mr. Wilcox, Mr. Filmer and others, and by 1858-59 the electrotyping business may be said to have become established on a practical basis; so much so that the process was quite generally employed for the reproduction of wood cuts.

In the meantime electricians had been busy with the problem of producing a continuous current of electricity by mechanical means which could be substituted for the battery. Machines more or less useful for this purpose were constructed by Dr. W. Siemens, of Berlin, in 1857. Between 1860 and 1870, Gramme, Schuckert, Weston, Brush, and Wilde, brought out improvements of more or less value. The Wilde machines were the first to be used to any extent for electrotyping, and were first adopted, about 1872, by Frank Leslie and Lovejoy, Son & Co., of New York City. They accomplished a revolution in the art by reducing the time required to deposit a shell to about three hours. Invaluable as these first machines were

to the electrotyping trade, they soon gave place to improved types, until at the present time it is possible to produce an electrotype shell thick enough for ordinary purposes in one hour or less.

Improvements in molding, blackleading and finishing machinery have kept pace with the advancing methods of electrotyping proper. In 1855, Mr. J. A. Adams invented a blackleading machine with a vibrating brush and traveling carriage. In 1856, Mr. Filmer patented a method of backing electrotype shells, by means of which the shell was held down by springs during the operation of casting. In 1858, Mr. S. P. Knight invented an improvement in the preparation of electrotype molds for the bath which was of great value to the trade and is universally employed at the present time. His invention consisted in precipitating a thin film of copper on the mold previous to immersing it in the bath. This is accomplished by flooding the mold with a solution of sulphate of copper and then dusting iron filings over it. The effect of the operation is to cause the deposition of copper to begin immediately over the entire surface, instead of beginning only at the points of contact and spreading slowly therefrom to other portions of the mold. Mr. Knight also invented, in 1871, a process for applying blacklead to the molds in the form of a solution, distributing it over the face of the mold by means of a traveling rose nozzle.

Many other improvements of a minor nature, which we have not space to describe, have been made from time to time, and the art of electrotyping may be said to be now in a high state of perfection.

In 1857, Alfred Smee made the remark that "electrotyping is likely to be useful for the Bible, Shakespeare, 'Pilgrim's Progress,' or works that have a large circulation." But the world has made wonderful progress in forty years, and the art of electrotyping has kept up with the procession. Improved methods, labor-saving machinery, cheapening material and the skill which comes from long experience have combined to reduce the cost and improve the quality of the product, and to-day electrotyping has become an indispensable auxiliary to the printing business. It is perhaps safe to say that seventy-five per cent of the books published during the last decade have been electrotyped, to say nothing of innumerable engravings and jobs of all kinds which have passed through the electrotypers' hands. Fifty years ago there were in existence perhaps a dozen electrotyping plants. There are in the United States alone about two hundred and fifty establishments having an estimated annual output of over \$5,000,000. To such proportions has grown a business that had its beginning a half a century ago in a quart jar.

## CHAPTER II.

## THE BATTERY.

ELECTROTYPING as applied to the manufacture of printing plates may be briefly described as follows : A mold of the object to be copied is taken in beeswax and suspended, together with a plate of copper, in an acidulated solution of copper sulphate. The mold is attached to the negative pole of a battery or dynamo and the copper plate to the positive pole. The electric current passing through the bath decomposes the solution and sets the copper free on the wax mold, depositing it in an unbroken sheet. When the copper shell has become of sufficient thickness it is removed from the mold, strengthened with a backing of soft metal, straightened, shaved, trimmed and blocked, and is then ready for the printing press. As thus described the process is apparently a simple one ; but it is, in fact, an art which demands a high degree of manipulative skill and the closest attention to detail.

The electric current which makes the electrototype possible must be of a certain strength and tension. If too strong or too weak, the deposited copper would be brittle, crystalline or spongy, and unsuitable for electrotypes. It is obvious, therefore, that the source of electricity is a most important consideration. The dynamo is now so generally employed for electrotyping that a detailed description of the galvanic battery would seem

to be out of place were it not for the fact that there are possible conditions under which the battery may still be found useful—such, for instance, as small experimental work, the deposition of copper during the night, or under other circumstances where power for operating the dynamo is not available.

In discussing the galvanic battery no effort will be made to consider the theory either of its action or the effect of the current on the solution. It will be sufficient to consider simply those facts a knowledge of which is essential to the successful practice of electrotyping. A plate of zinc and a plate of silver immersed in acidulated water and connected together with a wire will generate a current of electricity, and if this current is passed through a copper sulphate solution under proper conditions the solution will be decomposed. Why this is so and how it is done are matters concerning which various theories have been published in books devoted to these subjects and to which the reader is respectfully referred.

While a scientific education is not essential to the successful practice of the electrotypist's art, he should possess a sufficient knowledge of chemistry and of the principles of electro-metallurgy to enable him to properly prepare and care for his solutions and to recognize the cause and apply the remedy for the difficulties which will occasionally confront him. It is essential, also, that the student of this subject shall become familiar with certain technical terms which are unavoidable in a discussion of the subject. The following list will be found to contain most of the words and terms peculiar to electrotyping :

*Positive plate*, the active element (zinc) of the battery. *Negative plate*, the inactive (silver) element of the battery. *Positive pole*, the wire attached to the silver plate by which the current leaves the battery. *Negative pole*, the wire attached to the zinc plate by which the current returns to the battery. *Electrodes*, the immersed surfaces of metal or other conductor, by which the current enters and leaves the liquid. *Anode*, the pole or plate by which the current enters the solution. *Cathode*, the wax mold or other surface receiving the deposit and by which the current leaves the solution. *Volt*, the unit of electro-motive force. *Ampere*, the unit of current strength. *Watt*, a current of one ampere at the pressure of one volt.

There is hardly any limit to the number and variety of galvanic batteries extant, but for various reasons the one invented by Mr. Alfred Smee and bearing his name has been found most suitable for electrotyping. When a plate of copper and a plate of zinc are immersed in acidulated water and connected together with a wire, a current of electricity will at once begin to circulate, starting at the zinc, or positive plate; passing through the fluid to the copper, or negative plate, and thence through the connecting wire back to the zinc. The current thus generated is at first powerful, but gradually decreases in strength and finally ceases altogether, owing partly to so-called local action in the zinc plate and partly to the adherence of hydrogen bubbles to the copper plate, which have the effect of insulating it. The local action referred to is caused by particles of other metals, such as lead and tin, which are nearly always present in zinc to a greater or less extent.

These foreign metals form minute but independent batteries in themselves, which serve to rapidly dissolve the zinc. This local action may be minimized by amalgamating the zinc plate with mercury, which is done in the following manner: After thorough cleaning with caustic potash or dilute sulphuric acid, the zinc plate is placed in a shallow vessel and every part of its surface carefully coated with mercury mixed with a little sulphuric acid. The coating may be applied with a flannel cloth tied to a stick or in any convenient manner, and should be well rubbed in.

The adherence of hydrogen bubbles to the copper plate may be prevented to a large extent by roughening its surface. Mr. Smee improved upon this plan by substituting a silver plate for the copper plate and roughening the surface of the silver by platinizing. The first cost of silver plates is considerable and platinizing is also an expensive process, but the Smee battery is so far superior to the zinc-copper battery for electrotyping that the difference in first cost is a matter of small consequence. Solid silver plates are seldom employed in the battery, heavily plated copper plates having been found to answer the purpose nearly as well. Platinizing is effected by suspending the silver plate in a saturated solution of bichloride of platinum and acidulated water in the proportion of one part solution to thirty parts water. In the same vessel opposite the silver plate is a porous cell containing sulphuric acid and water (1 to 10) with a zinc plate suspended in it. On connecting the zinc and silver plates with a wire the platinum in the solution will be deposited on the silver plate in the form of a nearly black powder, which roughens the surface

of the plate and effectually prevents the adherence of hydrogen bubbles.

A battery may consist of one or more sets of plates, the number and size of plates to be determined by the amount of work to be performed. To produce the best results the surface of the zinc element in the battery should equal the cathode surface in the depositing bath. That is to say, if it is desired to deposit copper on four molds at one time, each one square foot in area, then the battery should contain an equal area of zinc surface; a convenient size for the plates in a battery of this capacity would be 12 by 12 inches. A battery made up of four zinc and two silver plates, each twelve inches square, would deposit a good quality of copper over eight square feet of area.

The electro-motive force of one Smee cell is sufficient to deposit copper on shallow molds, and there is, therefore, no necessity for employing more than one cell for ordinary electrotyping, but care should be taken to make the cell large enough to accommodate a sufficient number of zinc plates to equal the area of the molds in the depositing bath. In this connection it may be explained that while a strong current may be employed in electrotyping, but very little tension or electro-motive force is required, and it is well to remember that the size of the battery or the number of plates it contains, have nothing to do with its electro-motive force or the pushing power of its current. A cell of one quart capacity has the same E. M. F. as one of 100 gallons, but the strength or quantity of current depends on the area of zinc surface attacked. It is, therefore, essential in making up a battery for electrotyping to connect all the zinc

plates to one electrode, and all the silver plates to the other. As before stated, the E. M. F. of one cell is sufficient for ordinary electrotyping; but for such work as steel or nickel facing, one cell would not have sufficient power to overcome the resistance offered by the iron or nickel solutions, and it becomes necessary to couple two or more cells together by connecting the zincs of one cell with the silvers of the other. In this

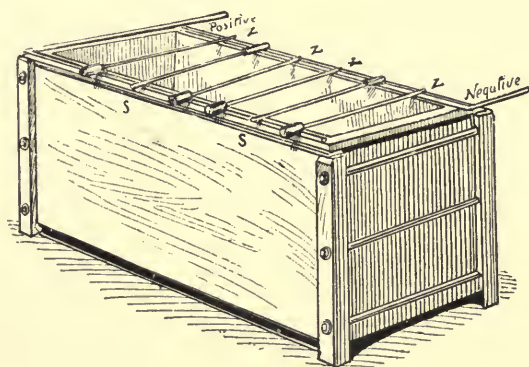


FIG. 1.  
ELECTROTYPE BATTERY.

way the power of the battery to overcome resistance is increased in proportion to the number of cells employed, but the strength of the current remains the same unless the area of zinc surface attacked should also be increased.

In Fig. 1 is illustrated a single-cell battery showing the electrode and cross-rods for supporting the zinc and silver plates. This cell is 18 inches long, 18 inches deep and 16 inches wide, and is designed for four zinc

and two silver plates, each 12 inches square. This battery is large enough to deposit from eight to ten feet of copper at a time. The electrodes are  $\frac{3}{4}$ -inch copper rods, and the cross-rods are  $\frac{1}{2}$  inch in diameter. The vat is constructed of pine or whitewood planks, bolted together, and is lined with asphaltum.

To obtain satisfactory shells at a minimum expense, the battery should receive careful attention. The zinc plates must be kept thoroughly amalgamated to prevent waste. With this object in view the plates should be frequently examined, and when dark spots are observed the plate should be reamalgamated. When not in action the zinc plates should always be removed from the cell. The battery should be stirred as often as every other day to equalize the solution, which becomes dense from the addition of sulphate of zinc. A little acid and water must also be added from time to time to keep up the strength of the battery. In mixing acid and water the acid should always be added to the water, and this should be done very slowly and carefully to avoid sudden heat and consequent danger of explosion. The silver plates require very little attention except an occasional washing, but should be platinized two or three times a year if in constant use.

After being in action about a week the battery usually becomes so impregnated with sulphate of zinc that the addition of acid has little or no effect upon it. If the quantity of sulphate becomes excessive, it will crystallize on the positive element and entirely stop the action of the battery. When such conditions appear, it is better to throw away the contents of the battery than to attempt a remedy.

## CHAPTER III.

## THE DYNAMO.

AS previously stated, there are certain conditions under which the galvanic battery may be found useful as a current generator for electrotyping, but it should be understood that in every respect except the quality of copper deposited the battery is inferior to the dynamo. Compared with the machine the battery is both slow and expensive. A shell which would require twelve hours' time to deposit with the battery may be deposited in one hour with the dynamo, and leaving the time element out of consideration the actual cost of deposition by the battery method is probably six times as great as by the machine. Theoretically a pound of copper should be obtained for each pound of zinc and acid consumed in the battery, but in actual working the consumption of zinc amounts to nearly two pounds. With zinc at 7 cents per pound, a copper shell  $\frac{5}{16}$  of an inch in thickness would cost for deposition about 3 cents per square foot. On the other hand, a dynamo with a capacity of 160 square feet per day can be operated at an expense for power of not to exceed 75 cents, or about  $\frac{1}{2}$  cent per square foot. The current generated by the dynamo is powerful, uniform, and easily managed; while the machine itself requires but little attention, is clean and always ready for business.

Dynamos of various sizes and types are now manufactured specially for electrotyping and plating purposes,

and the electrotyper is offered an unlimited assortment from which to choose. Dynamo building is no longer a mystery, and its principles are so well understood that there is no more excuse for building an inferior machine than there would be for building a poor steam engine.

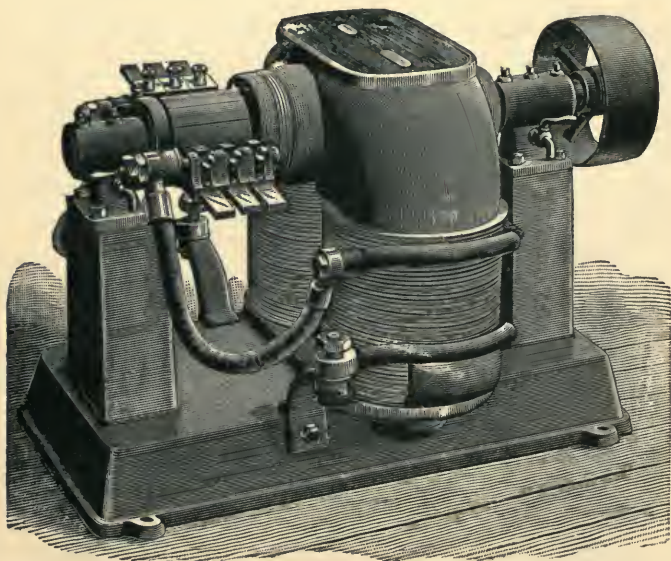


FIG. 2.

ELECTROTYPING DYNAMO.

There is, therefore, little danger of disappointment if the dynamo is purchased from a reputable manufacturer, provided the requirements of the machine are thoroughly understood by purchaser and seller. It would be folly to attempt to force a ten-horse engine to do work requiring twenty horse-power, and it is equally

foolish to expect a dynamo to do more work than it is designed to do. Here is where an error is often made. To save the few dollars difference in first cost a small machine is installed, overloaded and condemned, when the fault is not in the machine but in the man who overloads it. Competition between builders of dynamos induces them to claim for their respective machines the utmost limit of their capacity when running under the most favorable conditions, and as the conditions are not always favorable, dissatisfaction results. The electrotyper should himself have a definite idea of the number of square feet he will require to deposit at one time and the speed at which he wishes to work, for it is true in electrotyping as in mechanics generally that "we cannot get something for nothing." A dynamo which will deposit 100 feet of shells in two hours will deposit only 50 feet in one hour, and if a rapid rate of deposition is desired a correspondingly large machine must be employed.

Authorities differ somewhat in their estimates as to the maximum current density which may be employed in electrotyping ; but it is safe to figure on about twenty-five amperes per square foot with the solution at rest and about fifty amperes with the solution in motion. On this basis, a dynamo of 500 amperes, with an E. M. F. of  $1\frac{1}{2}$  volts working one vat, would deposit about twenty feet at a time. If speed were no object a somewhat larger area could be covered by reducing the voltage. The most economical method of utilizing the current, and the one generally employed, is to connect the machine to two vats in series. By this means the current is utilized in both baths before it returns to

the machine and the capacity of the dynamo is nearly doubled. Fig. 3 is a plan view of a double vat, showing the method of connecting the dynamo in series. The current leaving the machine traverses the electrode *a*, enters the solution in the first vat by anode (1), passes through the solution and leaves the vat by cathode (3) and the dead rod *c*, enters the second vat by the anode (2), leaves it by cathode (4) and returns to the dynamo by electrode *b*. By this method the current is made to do duty in both vats; but inasmuch as the resistance of two solutions is double the resistance of one solution, the E. M. F. of the current must be double what would be required for a single bath. If one volt pressure will overcome the resistance of one solution to an extent sufficient to accomplish a satisfactory rate of deposition, then two volts will be required to effect the same rate of deposition in two

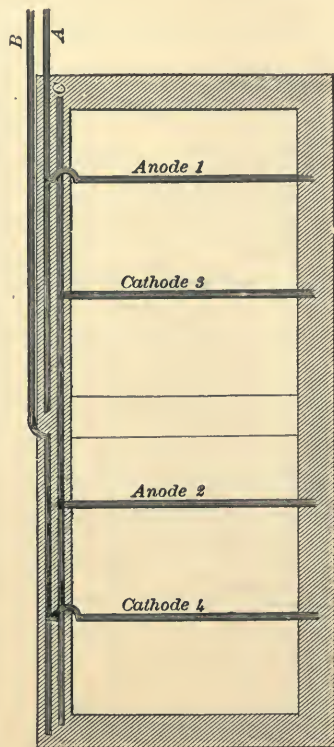


FIG. 3.  
DYNAMO CONNECTIONS ON DOUBLE  
VAT.

vats. It should be remembered that within certain limits the rate of deposition depends on the strength of current employed, and this fact should have due consideration in estimating the capacity of a machine. A good quality of copper may be deposited with a current density of thirteen or fourteen amperes per square foot, but the rate of deposition would be slow. On the other hand, fifty or more amperes per square foot may be employed, under proper conditions, with a corresponding increase in the rate of deposition, but at an additional expense for power. In the first case, roughly speaking, about four hours would be required to deposit a shell  $\frac{5}{16}$  of an inch in thickness, while in the latter case one hour would be sufficient to deposit the same weight of copper. In the first case a 500-ampere machine on one vat would deposit about thirty-five feet at one time, while in the latter case it would deposit only one-fourth as large an area, but would accomplish the work four times as fast. In the long run the result would be the same so far as the total quantity of copper deposited is concerned, and where speed is no object the former current density is preferable because more economical in power.

It has been stated that fifty or more amperes per square foot of cathode surface may be utilized in electrotyping under proper conditions, and that shells of average weight may be thus deposited in about one hour. To effect such a rapid rate of deposition it is essential, first, that the dynamo shall be constructed to supply a large volume of current without dangerously heating the machine; second, the solution should be properly proportioned; third, the solution or the anodes

must be kept in constant motion; and fourth, all connections must be of large size, and the points of contact clean and firmly made.

Large plants, in which more than two vats are operated, usually employ more than one machine. In other words, it is considered good policy to employ two dynamos for four vats, rather than to couple all four vats to one dynamo. The object of such an arrangement is that one-half the plant may be discontinued during a dull season, and it also permits the use of low voltage machines, such as are carried in stock by the manufacturers. From what has been previously said on this subject, it will be obvious that a dynamo working four vats in series would require to have four times the voltage needed for one vat, and twice the voltage needed for two vats. If a very rapid rate of deposition is desired, a machine working four vats would need to be operated at a tension of eight or ten volts, whereas a tension of four to five volts would be sufficient for two vats. Machines of the latter capacity are of standard make, while it is probable that a ten-volt dynamo would have to be specially constructed.

When purchasing a dynamo, consideration should be given to the possible maximum output of the foundry, as well as the rate of deposition desired. If the plant includes but one molding press and one black-leading machine, and rapid work is not imperative, a dynamo of 450 amperes and two volts would take care of all the work which could be turned out, for such a machine working two vats in series would deposit from forty to fifty square feet at one time, and would deposit a sufficiently heavy shell in about three hours. In other

words, it would deposit about fifteen feet per hour, which would probably be the limit of the capacity of a foundry of the indicated size. If, however, it is desired to deposit fifteen feet every hour instead of forty-five feet every three hours, a much larger machine would be required, for, as has been before stated, the rate of deposition depends principally on the strength of current employed; and while a sufficient current density for a limited number of shells could be obtained from the small machine, it could be applied to only one vat at a time, because sufficient E. M. F. could not be generated to force the current through two solutions at the maximum speed. The capacity of the machine in square feet of cathodes which could be deposited at one time would, therefore, be cut down to one-quarter of the surface which could be covered at slow speed.

To further illustrate this point, we will suppose a dynamo of 450 amperes and  $2\frac{1}{2}$  volts to be connected with two baths in series. Each bath would then be supplied with a current of  $1\frac{1}{4}$  volts pressure, and the quantity of current utilized would be approximately 30 amperes per square foot of cathode. The total capacity of the machine, 450 amperes, divided by 30, gives 15, the number of feet which can be deposited at one time in each bath, or a total of 30 feet. Now, if it is desired to double the rate of deposition, it becomes necessary to double the pressure of the current, which would mean 5 volts instead of  $2\frac{1}{2}$ . As the small machine cannot be made to produce 5 volts, the only alternative is to disconnect one of the vats. We now have  $2\frac{1}{2}$  volts applied to one bath, and are using about 60 amperes per square foot of cathode ; 450 divided by 60

gives  $7\frac{1}{2}$  as the maximum number of feet which could be deposited at one time, and this is in theory only, for in actual practice it is found impracticable to deposit more than 5 feet, owing to the tendency of the machine to heat. The economy in operating a large dynamo for rapid deposition is thus plainly evident.

The results of a series of tests recently conducted by the writer are given below :

|                                     |                |
|-------------------------------------|----------------|
| Dynamo .....                        | No. 1 Lloyd    |
| Speed .....                         | 1,350          |
| Volts .....                         | $2\frac{1}{8}$ |
| Amperes per square foot, about..... | 51             |
| Number of baths .....               | 1              |
| Area of cathodes, square feet.....  | 7              |
| Time of exposure, minutes.....      | 60             |
| Thickness of deposit, inches ....   | .003           |

A similar test of a No. 1 Eddy dynamo produced the same result. It should be said that during the tests these machines were both operated at higher speeds than those mentioned, with the result that shells .007 of an inch were deposited in one hour; but owing to heat generation only two or three square feet of cathode surface could be exposed at one time.

A test of a larger machine resulted as follows :

|                                            |                |
|--------------------------------------------|----------------|
| Dynamo .....                               | No. 2 Lloyd    |
| Speed .....                                | 1,000          |
| Volts, per vat.....                        | $2\frac{1}{4}$ |
| Amperes per square foot of cathode, about. | 54             |
| Number of baths in series.....             | 2              |
| Area of cathodes, square feet.....         | 20             |
| Time of exposure, minutes.....             | 60             |
| Thickness of shell, inches .....           | .0035          |

These tests indicate that a dynamo of 800 amperes and 5 volts, working two baths in series, will deposit,

without undue heating, about twenty-eight feet of shells per hour; while a 450-ampere,  $2\frac{1}{2}$ -volt dynamo will only deposit about seven feet per hour. It appears, therefore, that rapid deposition is not practicable with a small machine. However, the difference in cost of installation is of slight moment in view of the increased product of the large machine, and should not stand in the way of the better service, particularly as the larger dynamo will perform a limited volume of work equally as well as the smaller, and at only a nominal increase in expense for power. In later tests with larger dynamos and an agitated solution the current strength was increased to 125 amperes per square foot, with the result that practical shells were produced in fifteen minutes. The above mentioned tests are given with the object of indicating how present facilities may be utilized to the best advantage by electrotypers whose machines equal or excel the capacity of the No. 2 Lloyd.

Dynamos, as a rule, require but little attention, but should always be kept clean and well oiled. The commutator, in particular, should be occasionally cleaned with a piece of fine sandpaper (not emery paper) and then wiped off with a clean, damp cloth. Slow-speed machines require no lubricant on the commutator other than an occasional wiping with a damp cloth. On high-speed machines a very little vaseline may be applied every two or three hours. The brushes should fit the commutator fairly well, otherwise there will be a tendency to spark and heat. Sparking should never be permitted, as it rapidly wears the commutator. It may often be prevented by moving the brushes a little one

way or the other from the position in which the sparking occurs.

For nickel-facing electrotypes a current tension of  $2\frac{1}{2}$  to 3 volts is required, and for this work a separate dynamo is usually employed; but when the electrotyping dynamo is sufficiently powerful the nickel bath may be operated in connection with the copper baths by providing it with a resistance coil for regulating the strength of current supplied to it. With a dynamo operating at  $2\frac{1}{2}$  volts it would be possible to work the nickel bath without a resistance coil, as in this case a sufficient variation of current strength could be obtained by varying the distance between the cathodes and anodes. But if the tension exceeds  $2\frac{1}{2}$  volts, a means must be provided for cutting down the current to the point best suited to the conditions of the work.

## CHAPTER IV.

## THE BATH.

THE depositing bath for electrotyping in copper consists of a solution of blue vitriol acidulated with sulphuric acid. Copper sulphate, blue vitriol, or blue stone, as it is variously termed, forms crystals which when unadulterated are pure blue in color and cannot be mistaken for any other chemical. A green tinge indicates the presence of sulphate of iron and should be rejected. While the color is a sufficient guide to the purity of the sulphate it may be further tested by boiling a small quantity of the solution with a little nitric acid and adding spirits of ammonia in excess. The presence of iron will be indicated by brown flakes. Distilled water or filtered rain water should, if possible, be used in making the solution. If rain or distilled water cannot be conveniently obtained, well or lake water will answer, but should always be thoroughly boiled and filtered.

Sulphuric acid (oil of vitriol) for acidulating the solution should be used pure and concentrated. The crude acid contains arsenic which renders it unfit for use in electrotyping solutions. The pure acid has a specific gravity of 1.84. It may be recognized by mixing one part with twenty-five parts of distilled water and compounding with a few drops of barium chloride, when a white precipitate will be formed. In diluting acid with

water it should always be added to the water very slowly and with constant stirring, as the heat generated by the contact of the acid and water might otherwise be sufficient to cause a dangerous explosion. Sulphuric acid is exceedingly corrosive and should always be kept in glass bottles or carboys.

The copper solution is the least troublesome of all electrolytes. While some baths require accurate proportionment, the use of distilled water, and even an exact degree of temperature for their successful operation, the copper bath may be widely varied in proportion and will work well under considerable variation of temperature. Nevertheless, there are certain limits or proportionment which must be observed to obtain rapid deposition of a good quality of copper; for, while the rate of deposition depends very largely on the strength of current, it is essential that the solution be constituted to work in harmony with the current. The essential qualities of the solution are to present the least possible resistance to the electric current and to dissolve the anode with the same rapidity with which the copper from the solution is deposited on the cathode. A solution of copper sulphate without the addition of acid will conduct electricity, but its resistance is such that a very strong current is required to overcome it. Von Hübl found that the minimum current density per square foot of cathode in a fifteen-per-cent blue vitriol solution without acidulation is 24.1 amperes, while the same solution with six per cent sulphuric acid added required but 13.9 amperes. But while it is thus shown that the addition of sulphuric acid lessens the resistance

of the solution, there remains a wide difference of opinion as to the maximum quantity of acid which may be employed to advantage.

It is not difficult to prepare a solution which with a moderate current will deposit copper of good quality at a moderate speed. As an evidence of this fact it may be stated that it would be difficult to find two solutions exactly similar, the variations extending from twelve to twenty-two per cent blue vitriol, and from two to eight per cent acid. However, there is no question but that a moderately rich solution is preferable and even necessary for rapid work. A solution poor in copper will deposit quickly, but the shells are apt to be porous and granular. On the other hand, a solution too rich in copper will deposit slowly and in crystalline form. Deposits of this nature are specially noticeable when a weak current is employed, and it is also noteworthy that a poor solution is much more apt to produce granular deposits when the current is strong. From these facts it appears that a richer solution may be employed with a strong than with a weak current. Almost any kind of a solution, within reasonable limits, will do good work if the current strength is adapted to work in harmony with it. That is to say, by observing the quality of copper deposited and increasing or decreasing the current strength as the conditions demand. For instance, if a pulverulent deposit is obtained it is an indication that the current is too strong or the solution too weak, and the defect may be most easily remedied by reducing the current strength either by means of a switchboard or by decreasing the speed of the dynamo.

On the other hand, a crystalline, brittle deposit indicates a weak current or a rich solution, and may be remedied by increasing the dynamo speed. However, if rapid deposition is desired the solution must be constituted to work with a strong current, and defects in the deposit should be remedied, so far as possible, by changing the solution rather than the dynamo, inasmuch as a reduction in the speed of the machine would retard the rate of deposition. Of course, there are well-defined limits to the current strength which may be effectively employed with any solution, and it should be the object of the operator to determine the highest effective point of harmony between the two. With the bath at rest, a fourteen to sixteen per cent solution acidulated with two to three per cent sulphuric acid and a current density of fifteen to eighteen amperes per square foot has been found most satisfactory. An agitated solution may be made somewhat richer if a stronger current be employed, say eighteen to twenty per cent blue vitriol and three to six per cent acid.

The depositing vat for the copper solution should be solidly constructed of pine or whitewood planks bolted together and lined with sheet lead united at the corners by "burning" or melting the sheets together. Soldering will not answer, as the acid in the solution will attack the solder, and soon eat its way through. The vat should preferably be partitioned into two compartments, in order that the dynamo may be operated in series, as previously described. It is essential also that the vat shall be of ample size. The resistance presented to the electric current by the solution is enormous,

and only a great area will compensate for its lack of conductivity. At least 100 gallons of solution should be provided for each twenty feet of cathode surface exposed. A convenient size and shape of depositing vat is shown in Fig. 4. The length is 60 inches, width

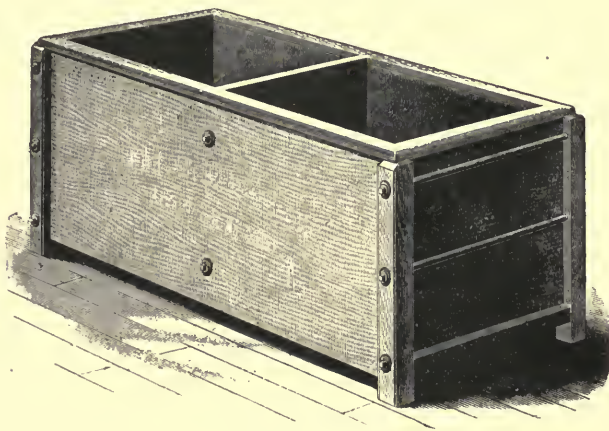


FIG. 4.—ELECTROTYPYER'S DEPOSITING VAT.

30 inches, and depth 26 inches. It will contain about 200 gallons of solution, and will accommodate about ten cases of average size in each compartment.

In mixing the solution the vat should be about two-thirds filled with rain, distilled or boiled water. The blue vitriol may be conveniently dissolved by suspending it in cheese-cloth bags just under the surface of the water. As the water becomes saturated it will sink to the bottom of the vat, and should be frequently stirred and tested with a Baumé hydrometer. when 14 or

15 degrees is indicated on the instrument the bags of vitriol may be removed and sulphuric acid added to the solution, with constant stirring, until the reading of the hydrometer is increased two or three degrees. This solution will work well with a moderate current. If the current strength is more than 20 amperes per square foot, the solution may be enriched by the addition of blue vitriol to the extent of two or three degrees, and if required as many degrees of acid may also be added.

The solution should be well stirred, and may be used at once, although it usually works better after standing a few days.

## CHAPTER V.

## STEEL, BRASS AND NICKEL BATHS.

COPPER is almost universally employed for the production of electrotypes for printing purposes, and generally speaking it is the most suitable of all metals for this purpose. It is easily deposited, is tough, ductile, practically non-corrosive and inexpensive. However, it is too soft to stand the wear of very large editions, and it does not print well with colors containing mercury, which chemically attacks copper. To overcome these defects it is customary, when the circumstances are such as to warrant the extra labor and expense, to face the copper electrotype with steel, brass or nickel. This is effected (*a*) by suspending the finished electrotype in the proper solution and depositing thereon a film of harder metal, or (*b*) by suspending the wax or other mold in the hard-metal solution, obtaining thereon a preliminary deposit, and then transferring it to the copper bath where it is strengthened by a sufficiently heavy deposit of copper. Of these methods, the former is the more readily performed and the latter the more accurate in results. By the former method it is obvious that only a very thin facing can be given to the electrotype without impairing its accuracy, and it is doubtful if any kind of a facing could be given to a fine-screen half-tone by this method

without destroying something of its delicacy. However, electrotype plates of ordinary character may have a thin facing of harder metal deposited upon them without perceptibly affecting their accuracy.

Of the three metals employed for facing electrotypes, nickel is the more readily deposited and its solution the least troublesome to manage. It is malleable and ductile, and nearly or quite as hard as iron. Moreover, it is non-corrosive and altogether is an ideal metal for the purpose. Various solutions are recommended for the nickel-depositing bath, each of which has its advocates, but many of them are more or less complicated and require special care in management. A simple bath which has been thoroughly tested in some of the largest electrotyping establishments in the country is made by dissolving the double sulphate of nickel and ammonia in warm water in the proportion of  $\frac{3}{4}$  of a pound of the salts in each gallon of water. The procedure is the same that has been recommended for the copper solution, i. e., the salts should be suspended in cheese-cloth bags just under the surface of the water until entirely dissolved, when the solution should be well stirred and is then ready for use. Some operators add about ten per cent of common salt to the solution for the purpose of increasing its conductivity.

The deposition of iron is attended with more or less difficulty, and is not always successfully accomplished even by experienced operators. A good bath for iron (steel) facing may be made by dissolving two pounds of the double sulphate of iron and ammonia in each

gallon of water. Another bath, recommended by Urquhart, is prepared by adding a solution of carbonate of ammonia to a solution of sulphate of iron until the iron is precipitated, when the liquid portion should be poured off and the precipitate washed, after which it is dissolved to saturation in a bulk of sulphuric acid equal to the volume of solution required.

Another iron solution consists of 56 pounds of carbonate of ammonia dissolved in 35 gallons of water and supplied with iron by means of a large anode and an electric current from the dynamo.

The solution which seems to be most popular for the production of iron electrotypes, and which is highly recommended by M. Klein, is composed of equal parts of sulphate of iron (green vitriol) and sulphate of magnesia, kept neutral by bags of carbonate of magnesia suspended in the bath. A sufficient quantity of the sulphates should be dissolved in water to make the specific gravity 1.55, i. e., about 51° Baumé. This bath requires a current density of 18.5 amperes per square foot. A peculiarity of all iron solutions is that the anodes must always be of large size, preferably about eight times as large as the cathodes.

The deposition of brass is also attended with some difficulty, chiefly because it is composed of two metals, one of which is positive and the other negative, hence the current strength requires more or less regulation to insure uniform deposition of both metals. As brass is composed of copper and zinc, the salts of these two metals must necessarily form the basis of the depositing solution. A good brassing solution consists of 16

ounces of cyanide of potassium, 5 ounces carbonate of copper,  $1\frac{1}{2}$  ounces carbonate of zinc, 1 ounce of ammonia, and 1 gallon of water. The following formulas are recommended by Roseleur and Dr. Langbein: Copper sulphate and zinc sulphate, each  $5\frac{1}{4}$  ounces, and crystallized carbonate of soda,  $15\frac{3}{4}$  ounces. Crystallized carbonate of soda and crystallized bisulphide of soda, each 7 ounces; 98 per cent potassium cyanide,  $8\frac{3}{4}$  ounces; arsenious acid,  $30\frac{3}{4}$  grains; water, 10 quarts. The bath is prepared by dissolving the copper and zinc sulphates in 5 quarts of warm water, and in the other 5 quarts, the  $15\frac{3}{4}$  ounces of carbonate of soda; then mix both solutions, which will form a precipitate of the carbonates of copper and zinc. After setting ten or twelve hours the supernatant liquor is poured off and sufficient water added to the precipitate to make six quarts of solution. Now add to the bath with constant stirring the carbonate and bisulphide of soda. Dissolve the potassium in 4 quarts of cold water and add this solution to the first solution with the exception of one-half pint, in which the arsenious acid is dissolved by the aid of heat, when it is also added to the bath. This solution should be thoroughly boiled for one or two hours and the water lost by evaporation replaced.

Another brass solution, which is less troublesome to prepare, contains crystallized carbonate of soda,  $10\frac{1}{2}$  ounces; crystallized bisulphate of soda, 7 ounces; neutral acetate of copper, 4.4 ounces; crystallized chloride of zinc, 4.4 ounces; 98 per cent potassium cyanide, 14.11 ounces; arsenious acid,  $30\frac{3}{4}$  grains;

water, 10 quarts. Dissolve the carbonate and bisulphate of soda in 4 quarts of water, then mix the acetate of copper and chloride of zinc with 2 quarts of water and add this solution to the first ; retaining, however, a small portion of it in which to dissolve the arsenious acid with the aid of heat. Finally, add the arsenious acid solution, when the bath becomes clear. Boiling the bath or working it through with the current is required.

The following solution is recommended by Watt : Cyanide of potassium, 1 pound ; carbonate of ammonia, 1 pound ; cyanide of copper, 2 ounces ; cyanide of zinc, 1 ounce ; water, 1 gallon.

Another brassing solution which the writer has found very satisfactory consists of 16 ounces cyanide of potassium, 5 ounces carbonate of copper,  $1\frac{1}{2}$  ounces carbonate of zinc, 1 ounce ammonia, and one gallon of water.

Solutions containing cyanides would immediately destroy wax or gutta-percha molds, and their use is therefore restricted to plating or facing electrotypes or other metallic articles.

## CHAPTER VI.

## MANAGEMENT OF BATHS.

THE acid copper solution is not difficult to manage and may be kept for years in constant use by adding from time to time a little of one or the other of its constituents as may be needful to make good the loss occasioned by various causes. This loss is principally by evaporation, and by simply adding a few pints of distilled water the solution may generally be restored to nearly its original proportions.

Under ordinary conditions the copper withdrawn from the bath and deposited on the cathode is not fully replaced by the anodes, and it is necessary, therefore, to enrich the solution occasionally with a little sulphate of copper, which may be done by suspending just under the surface of the solution a few pounds of the crystals in a cheese-cloth bag. A reduction in the content of copper in the bath from this cause always produces a corresponding increase of free acid. Should the content of acid become excessive, it may be neutralized by the addition to the solution of a little carbonate of copper.

When the anodes are larger than the cathodes — or when, as may happen, a number of anodes are left in the bath, connected with the current, while molds are

being prepared for the depositing process—the quantity of copper dissolved will exceed the quantity deposited, resulting in undue concentration of the solution. This condition will be indicated by a tardy formation of the deposit and the production of a shell of brittle and crystalline character. Moreover, a dense solution, unless continuously agitated, is apt to produce streaky deposits. An excess of copper is further indicated by the formation of crystals of sulphate of copper on the sides of the vat and sometimes on the anodes. When such conditions appear, the obvious remedy is to dilute the solution with water. However, the addition of water to make good the loss caused by evaporation is usually sufficient to remedy any excess of copper without further dilution.

A quiescent solution always becomes more concentrated at the bottom than at the top of the vat. As a result of this condition the lower portion of the anode will be dissolved less freely than the upper on account of the increased resistance; but, on the other hand, the copper will be deposited more rapidly on the lower portion of the cathode where the largest quantity of metal is in solution. For the same reason that portion of the cathode which is suspended in the heavier strata of the bath is apt to become covered with nodules or excrescences which are more or less annoying and wasteful. This difficulty may be minimized by stirring the solution occasionally with a wooden paddle, which will temporarily equalize its density. The bath should not be stirred while in use, particularly if old and dirty, as the

impurities which will have settled on the bottom of the vat would be likely to lodge on the work and cause holes in the shells. Some electrotypers are content to stir the solutions once a week, usually on Saturday evening, thus giving the bath thirty-six hours in which to settle; but, unless very dirty, it is advisable to stir it as often as every twenty-four hours. When a bath has become so dirty that it cannot be agitated without danger of injuring the work it should be filtered.

The temperature of the bath should be kept between 65 and 75 degrees Fahr. At 65 degrees the best quality of copper is produced; but the quality is not seriously impaired by raising the temperature ten degrees, while the rate of deposition is materially increased. Baths located in a room not heated at night may be provided with a coil of lead pipe through which steam may be circulated and the temperature increased thereby as desired. Deposition always proceeds sluggishly on cold mornings, unless some provision for warming the solution is made. It is always desirable to keep the baths in a room separate from the molding and finishing departments in order to protect them as far as possible from dust and flying particles of metal. It is also a good plan to keep the vats covered when not in use.

The anodes should be removed from the solution daily, and thoroughly cleaned from the slime which accumulates on them and which has the effect of partially insulating them.

What has been said regarding the general care of the copper bath applies also to the nickel bath. An

occasional addition of water to restore the loss occasioned by evaporation is imperative, as is also the addition of a few crystals of nickel salts from time to time if the bath becomes impoverished.

Brass and iron baths are more troublesome than either copper or nickel. The brass bath requires frequent building up, particularly if not in regular use. As brass contains a larger proportion of copper than zinc, the copper in the bath becomes first exhausted, and sufficient carbonate or cyanide of copper, according to the constitution of the bath, must be added to restore the proper proportions. Cyanide of potassium must also be supplied when the action of the bath becomes sluggish and no bubbles are observed on the cathodes. When, however, there is a vigorous evolution of gas it is an indication of an excess of cyanide, and a slow deposit under these circumstances would be remedied by the addition of the metallic salts. A deposit of light color would indicate a want of copper in the solution, and a dark color a lack of zinc. However, the color is not a reliable guide, as it may be caused by a variation in the density of current employed. A weak current would deposit more copper than zinc and would give its color to the deposit, while a strong current deposits both metals in their proper proportions. Constant watchfulness is required to keep the brass bath in good working condition.

The iron bath is even more troublesome than brass and less certain in the production of satisfactory deposits. Owing to its tendency to oxidize, the bath must

be frequently filtered to insure uniform deposits. For the same reason it should be kept under cover when possible. The surface of anodes exposed should always be seven or eight times greater than the cathodes.

## CHAPTER VII.

## AGITATION OF BATHS.

THE continuous agitation of the copper bath is of great advantage to the electrotyper, particularly when rapid deposition is desired. The copper is more evenly deposited and of better quality, the formation of gas bubbles and also of nodules and excrescences is largely prevented, while the annoying streaks which sometimes appear on the deposit, usually as the result of an excess of metal in the solution, are seldom or never seen in an agitated bath. But the principal advantage may be found in the fact that much higher current densities may be utilized, resulting in a corresponding increased rate of deposition. With a quiescent solution the quantity of current which may be employed is limited to about 18 or 20 amperes per square foot; any excess of this quantity usually results in a deposit, dark red or black in color, and rotten, porous or granular in texture. But in an agitated bath these defects disappear. The copper becomes lighter in color, and tough and ductile in character, and these conditions will not change materially even when the current density is increased to 100 amperes or more per square foot.

A quiescent solution is seldom of equal density throughout. The heavier portions settle to the bottom

of the vat and the lighter portions rise to the top, and while the density of the bath may be temporarily equalized by occasional stirring, there is a continual tendency to separation. The evils resulting from this lack of homogeneity have been described in a previous chapter, and the remedy for these evils is continuous agitation. There are various methods by which this object may be accomplished. A small propeller may be operated near the bottom at one end of the vat, or, where several vats are employed, they may be arranged in steps and the solution permitted to flow through a connecting pipe from the upper vat to the next lower vat, and so on through the series.

Fig. 5 shows a depositing vat arranged for working by the Englehard process. For electrotyping, the anodes used are about 7 inches wide and  $1\frac{1}{2}$  inches thick, the length being as may be needed for the work in hand. They are mounted on spindles as shown, and by suitable arrangement are rotated by power while the battery is in action, the usual rate of speed being about fifty revolutions per minute. The agitation of the solution insures thorough mixture and uniform density; friction between the solution and the moving anode clears its surface of foreign matter and facilitates its rapid dissolution. This also permits the employment of much greater electrical energy than in vats as ordinarily worked—in fact, quite beyond the capacity of nearly every plating dynamo in use. The inventor claims a current of 6 or more volts per vat, and 75 to 100 amperes per square foot of cathode

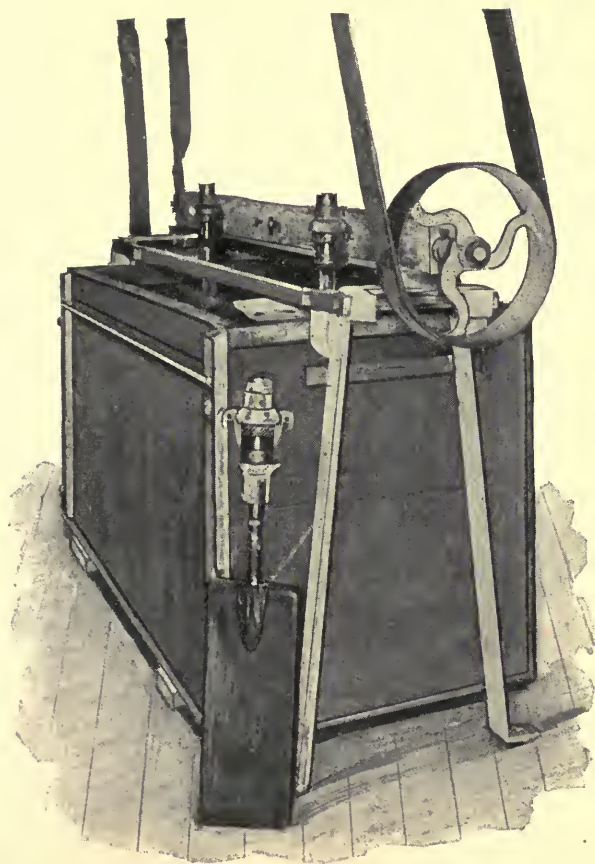


FIG. 5.

may be used without the least indication of burning the deposit, which is of finer quality than that usually made in the old way, and the quantity of metal thrown down is fully twice as much in a given time.

The Dunton method for producing a circulation in the solution is illustrated in Fig. 6. A small centrifugal pump, with a capacity of about 40 gallons per

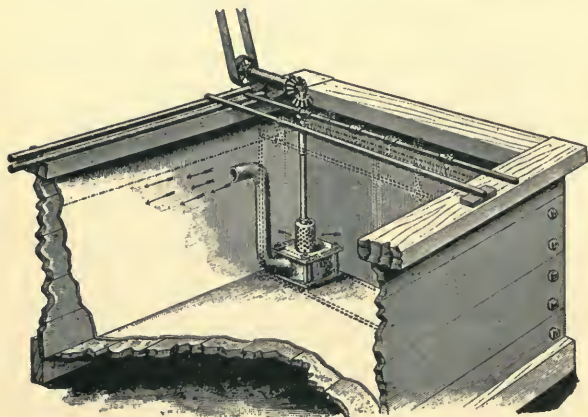


FIG 6.

minute, rests on the bottom of one corner of the vat. The solution is drawn in through a strainer at a point over the center of the wheel, near the bottom of the vat, and discharged near the surface. In this manner the heavier liquid is lifted, and by the force of its discharge a circular motion is imparted to the whole body. It is forced toward the end of the tub, where it glances

across, down the other side, some of it passing between the anodes and cathodes, across the opposite end to a point nearly over the pump. The pump occupies an area  $6\frac{1}{2}$  inches square by 4 inches high, and is constructed entirely of lead and hard rubber. Above the solution the shaft ends in a length of hardened steel tubing, which runs in the upper bearing and carries the driving gear. The two lower bearings, under the solution, consist of flint glass bushings pressed into hard rubber jackets, then forced into the sleeves provided at the top and bottom of the pump casing.

Fig. 7 illustrates the Leetham apparatus, which is particularly suitable for electrotyping solutions. Agitation is effected by air compressed in a reservoir by a small double-acting pump. The air is forced into the baths through perforated lead pipes which lie on the bottom of the vats, where they are entirely out of the way of the work.

The perforations in the pipes are only about one inch apart, which insures thorough circulation of the solution between the anodes and cathodes.

The pressure is regulated by valves, and the agitation may therefore be made more or less violent at the pleasure of the operator. On top of the air reservoir and connected with it is a condensing chamber through which the air passes before it is admitted to the vat. The condensing chamber is provided with an inlet for steam. When it is desired to increase the temperature of the bath or increase its contents of water, steam is admitted to the chamber, where it is condensed, and is

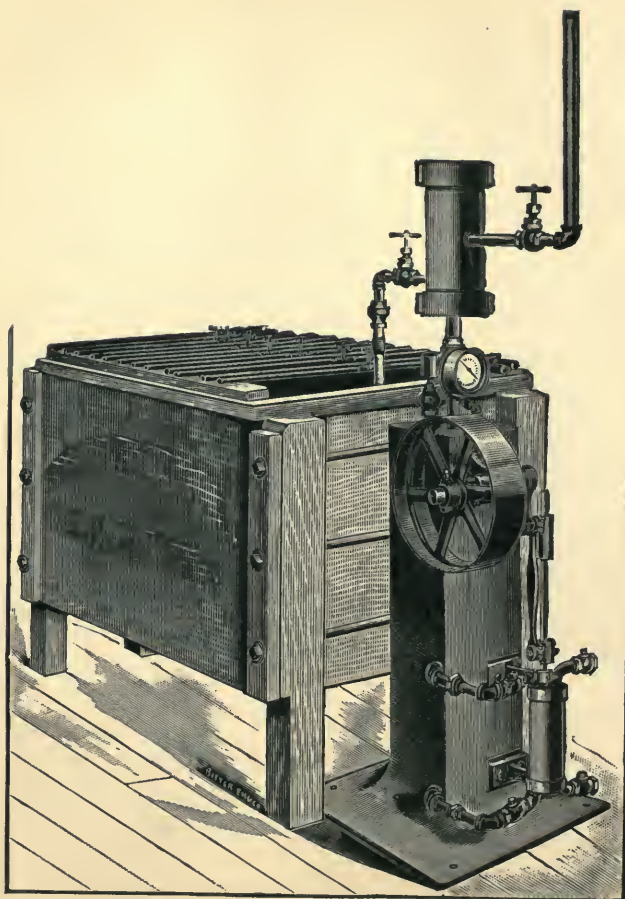


FIG. 7.

then conveyed to the solution through the air pipes. This device therefore provides a means for heating the solution and supplying it with distilled water as well as agitating it. Another obvious advantage of this apparatus is that one machine will agitate the contents of several vats.

## CHAPTER VIII.

## MEASURING INSTRUMENTS.

A CONVENIENT and almost indispensable measuring instrument in the electrotype foundry is the hydrometer, or, as it is popularly termed, acid gauge. By its aid the desired quantity of salts or acid in the bath may be conveniently measured, and the specific gravity of any solution readily determined. The hydrometer consists of a glass tube with a graduated stem of uniform diameter, a bulb to cause it to float in the liquid, and a weight to keep it upright as it floats. From the reading of the scale at the point which is on a level with the liquid in which it is floating, the density of the fluid may be ascertained. In pure water at a temperature of 60° Fahr., the hydrometer sinks to the zero mark, but by the addition of salts or acid having a greater density than water, the bulb is forced upward, and the reading on the scale will then indicate the increased density. In making up electrotyping solutions, the hydrometer is floated in a vat partially filled with water. Sulphate of copper is then dissolved in the water until the increased density of the solution forces the instrument upward to a reading which is

known to indicate the desired proportions. Sulphuric acid is then added to the solution until the desired quantity is denoted on the scale of the instrument. To further illustrate: a popular bath for nickel-plating is made by dissolving three-fourths of a pound of salts in each gallon of water; but instead of weighing the salts and measuring the water the same proportion may be obtained by dissolving salts in any quantity of water until the hydrometer scale registers 7 degrees. There are two well-known makes of hydrometers in use, namely: the Baumé and the Twaddle. Every degree on the scale of a Twaddle hydrometer represents .005 of a degree of specific gravity. Zero on the scale is equivalent to 1.000 specific gravity. To ascertain by a Twaddle hydrometer the specific gravity of any liquid heavier than water, multiply the reading by .005 and add 1.000. For example, the reading on the hydrometer is 60 degrees:  $60 \times .005 = .300 + 1.000 = 1.300$ , the actual specific gravity of the liquid. The specific gravity of a liquid may also be easily ascertained by means of a Baumé hydrometer by a simple calculation as follows: Subtract the reading from the number 144, and divide the same number by the difference. For example,  $144 - 50 = \frac{144}{94} = 1.532$ , the specific gravity of a liquid registering 50 degrees on a Baumé hydrometer.

Instruments for measuring electric currents should belong to the equipment of every well-ordered electrotyping establishment. In the early days of the art it

was sufficient to know that a current of some kind was at work and that in due course of time a shell of sufficient thickness would be deposited. It might take twelve hours at one time and eighteen at another, but a few hours more or less was not considered of serious moment. With the modern electrotyper, however, every minute counts, and as a rule he employs all the current strength which can be utilized without burning the deposit. Having learned by experience what quantity may be employed to advantage, it is of great convenience to be able to measure the current and by means of proper registering instruments maintain the pressure at the maximum point. Instruments for measuring electricity are the voltmeter and the ammeter. The former measures the tension and the latter the density of the current. While the scientific electrotyper would find both instruments convenient, the ammeter is not indispensable, for the strength of a current proceeding from a dynamo increases with the tension, and an instrument which registers the tension would, so far as the electrotyper's necessities are concerned, also measure the volume. Assuming that one volt pressure is sufficient to force a current of 12 amperes per square foot of cathode through a solution of given proportions, then with two volts pressure the current strength would be increased to 24 amperes and three volts would mean about 36 amperes per square foot. If, therefore, the electrotyper is provided with a voltmeter he may determine with sufficient accuracy for his purpose the strength of current employed.

The speed with which copper may be deposited depends on certain conditions, but more especially on the density of current employed. To reproduce such conditions at all times it is important that the E. M. F. existing between the anode and cathode should be accurately measured. The ordinary galvanometer is insufficient for this purpose because it does not give an accurate reading of the tension. On the other hand, a sensitive voltmeter will indicate any loss of power due to slipping belts, short circuits or irregularities of any kind, and when used in connection with a switchboard will enable the electrotyper to accurately reproduce the conditions which he has found by experience conducive to success.

The switchboard or resistance board consists of a number of metallic spirals, usually of German silver, arranged on a board in such a manner that one or more of them may be switched into the circuit, thus presenting more or less resistance, as may be desired, to the passage of the current. The utility of the switchboard may be illustrated as follows: suppose a tension of  $2\frac{1}{2}$  volts is desired in the bath and that by reason of slipping belts or other causes the tension has been reduced to  $2\frac{1}{4}$  volts. Then by moving the handle of the switchboard one or two buttons a corresponding number of spirals will be cut out of the resistance, permitting a larger quantity of current to enter the bath. Or suppose the load in the bath be much smaller than usual, or for any other cause the tension increases beyond the desired limit, a movement of

the switch handle in the opposite direction will increase the resistance by adding to the number of spirals in the circuit and the tension will thus be regulated. The wires connecting the voltmeter with the baths may be arranged in such manner that the tension in any one of a series may be readily determined.

## CHAPTER IX.

## PREPARATION OF WORK.

SUCCESS in electrotyping depends largely on careful attention to details, not the least important of which is the preparation of cuts or type forms for molding. The finished electrotpe must be perfectly flat to insure satisfactory printing. If the original form is defective by reason of imperfect justification, high or low cuts or type, the defects will necessarily appear in the electrotpe and must finally be rectified at the finishing bench. The truth of the old adage "A stitch in time saves nine" is nowhere better illustrated than in electrotyping. A few minutes' time spent in making ready the form for molding frequently saves hours at the finishing bench, particularly when a number of duplicate electrotypes are made from the same form. For instance, a broken or mashed type, unless discovered and replaced by a perfect one before the form is molded, will be a defect existing in every electrotpe made from that form and must be finally corrected by punching out the defective letter and soldering in its place a perfect type. These defects are not always the fault of the electrotper, but it is nearly always difficult to convince the

printer of that fact unless a proof is furnished by the printer with the job.

Printers' forms frequently consist of both type and cuts, and it often happens that the cuts are lower or higher than the type. Here again a few minutes' time spent in shaving down or underlaying the cuts, as the case may demand, will save much valuable time in the later operations of finishing, and will also insure a better electrotype, for it is obvious that if the cut is low in the plate it must be forced up to a level with the type by punching or hammering, and it will be plain, even to the novice, that a plate which has been subjected to such treatment will be less perfect than one which has been corrected in the original and which, therefore, requires but little attention from the finisher.

Usually better results are obtained by the molder from metal-mounted cuts than when they are mounted on wood, as the wood bases are liable to yield somewhat under pressure and will thus make a shallower impression in the molding composition than the surrounding type. Moreover there is danger of losing something of the detail of the engraving. This is more especially true of half-tone engravings, which should always be mounted on metal bases.

Wood engravings, when subjected to changes of temperature or atmospheric conditions, sometimes check or crack. When it is desired to make an electrotype of such an engraving, the checks, if not too large, may be closed by covering them with strips of damp blotting paper and then applying a hot building iron to the

paper until it is wholly or partially dry. When the check has been closed the mold should be made at once before it has time to open again.

Forms which are to be electrotyped should be surrounded by type-high beveled bearers with the beveled side next the type. The bearers prevent the wax or composition from spreading, and also serve to protect the face of the electrotype from injury during the operations of shaving and finishing.

When low leads, quads and furniture are used to justify the form, the larger blanks may be filled up to the shoulders of the type with strips of wax. The wax will adhere to the furniture sufficiently to hold them in place when the form is inverted on the case; and, on the other hand, if the wax filling is well brushed over with black-lead after it has been placed in the blanks, it will not adhere to the mold. Preparing the forms in this manner will prevent undue displacement of the molding composition and facilitate the later operations of cutting down and building. Parts of book pages or pages of poetry should have an inverted type placed in each corner of the page to indicate the size of the page and serve as a guide to the finisher, and title-pages and large blanks of all kinds should have inverted letters so placed as to protect isolated lines from injury during the finishing processes.

All forms which are to be electrotyped should be securely locked in extra strong chases and be perfectly justified. The type should be squarely on its feet and carefully planed. The pressure employed in molding is

such that unless great care is taken to lock up the forms securely the wax will be forced between the bodies of the type, causing them to spread and throwing them off their feet. This will result in an imperfect plate, and at the same time be the cause of much trouble and annoyance owing to the difficulty of removing the wax thus firmly imbedded in the form. Moreover, unless the form is securely locked, there is danger that some of the types will be drawn out of the form, when it is separated from the mold, and lost or misplaced.

## CHAPTER X.

## MOLDING.

THE most important department of electrotyping, from the workman's point of view, is the molding, and it is here that the question of profit or loss on a job is often determined. In some other departments of the foundry the work may be slighted to some extent without materially affecting the output, but carelessness or inefficiency on the part of the molder always means delay, extra expense for finishing inferior electrotypes, and possibly a final rejection of the job. A cheap (poor) molder is always the most expensive man in the foundry, for unless a perfect mold is obtained the time expended in later operations of depositing, casting and finishing will be wasted. Until recently the material most generally employed for molding composition was beeswax, mixed with a little crude turpentine and plumbago. The proportions vary somewhat, according to the ideas of the molder. A good combination is composed of pure beeswax eighty-five per cent, turpentine ten per cent and plumbago five per cent. If the molding room is very warm, about five per cent of burgundy pitch may be added with advantage. A cheaper material which is now quite generally employed is ozokerite. Ozokerite is a mineral wax, which can hardly be distinguished from beeswax. It has a

high melting point, is non-adhesive and by most electrotypers is claimed to be superior to beeswax for general work. In some instances gutta-percha is employed as a molding material, and under proper conditions the results obtained are very satisfactory. The kind best adapted for the work is what is known as the unmanufactured but purified sheet. Gutta-percha takes a coating of blacklead readily, and is impervious to the solution. When used for molding without pressure, as is usually the case in duplicating steel engravings or articles of a fragile nature, it is melted and thoroughly mixed with about forty per cent refined lard, or it may be dissolved in bisulphide of carbon, and then moderately heated until it is thin enough to pour.

A good molding composition for certain purposes may be made by melting together one pound of lead,  $\frac{3}{4}$  pound of tin, and  $1\frac{1}{2}$  pounds of bismuth. This alloy melts at the temperature of boiling water, and assumes a soft but firm condition just before setting, at which time the impression should be made. The principal advantage of this composition is found in the fact that it expands in cooling, and therefore takes a very sharp impression. An elastic composition recommended by Urquhart, which may be used for molding an entire object at one time, is prepared as follows: Eight pounds of good glue is soaked in cold water until quite soft. It is then placed in a glue-pot and mixed with two pounds of treacle. The whole is heated and thoroughly incorporated by stirring; when the mold is not likely to be roughly handled,  $\frac{1}{2}$  pound of beeswax may be added to the mixture. This material is poured around the prepared object, and when set

may be cut open from top to bottom and the object removed; the mold will now spring into its original position and shape. The tendency of this composition to absorb water may be prevented by immersing the mold in a weak solution of bichromate of potash and drying in the sun. An insoluble coating is thus secured.

A list of materials suitable for molding composition might be extended to include nearly any inelastic substance which can be sufficiently softened to receive an impression from type or cuts with a reasonable degree of pressure. At this writing admirable results are being obtained from pure lead under the name of the Doctor Albert process, a description of which will be found in another chapter. However, there is no material which, for general work, equals in popularity pure ozokerite or ozokerite mixed with a little beeswax. Freedom from lumps, fiber or grain insures a perfect medium for the production of the finest lines and shades of engraving. It may be easily softened by heat to the degree most suitable for molding and will not perceptibly shrink in cooling or recover its form after receiving an impression. Moreover it takes black-lead readily, is unabsorbent and may be used over and over innumerable times. In this age of adulterations it is not always easy to obtain pure wax, but most adulterations may be detected. The materials which are most commonly mixed with wax are paraffin, resin and tallow, and the presence of these substances may be suspected if the fracture is smooth instead of granular.

To prepare wax for molding it should be melted in a steam-jacketed kettle and heated for several hours to

expel all the moisture. About ten per cent of crude turpentine and five per cent blacklead should then be added and thoroughly incorporated. Having been thus prepared the wax is dipped out and poured through a strainer upon some shallow trays of brass or other metal and allowed to cool. These trays, or cases, are sometimes made of brass plates of a convenient size with the edges raised about one-fourth of an inch so as to form a shallow pan. Such cases are, however, quite expensive and entirely unnecessary, as a perfectly flat plate made of electrotype backing metal will serve the purpose even better than brass, for in the event of its becoming bent or warped it may be easily straightened by simply laying it on a flat surface and planing it down with a hammer and block. A raised edge may be obtained by surrounding the case with wood or metal strips of suitable height. It is customary to place the cases on a stone or iron table large enough to accommodate several at the same time and located within convenient distance of the wax-melting pot. When a stone table is employed for the purpose it should be very thick, not less than five or six inches, in order that it may quickly absorb the heat from the cases and thereby facilitate the cooling of the wax, otherwise much time would be consumed in waiting for the wax to set sufficiently to stand handling. Even a heavy stone table, unless of extraordinary size, will not cool cases fast enough when the volume of work is considerable, and under such conditions it is advisable to employ a hollow iron table provided with water and waste connections so that a circulation of cold water may be maintained and the time required to cool the

cases reduced to the minimum. Such a table may have permanently secured to its surface a strip of iron, three-eighths of an inch thick, extending entirely around the outside edge. The flat cases, about one-eighth of an inch thick, are then laid on the table and wax poured on them until it reaches the height of the  $\frac{3}{8}$ -inch strips. The cases may be separated, if desired, by strips of wood. After the wax has set, the cases are cut out with a knife and removed from the table, and the residue returned to the kettle. The iron table may be made still more effective by providing it also with steam connections, for it often happens on a cold morning that the table is too cold to cast perfect cases, and considerable time is consumed in producing the proper temperature by outside influences. In pouring the wax on the cases it is always advisable to strain it and thereby insure the exclusion of all dirt or foreign matter which may have found its way into the melting kettle. Immediately after pouring, a straight-edge or wire should be drawn over the surface of the cases to remove any air bubbles which may have formed. Any bubbles which do not yield to this treatment may be lightly touched with a gas flame. Neither wax nor composition material can be used for molding until some time after it has been cast in cases, or until it has had time to cool, and it is therefore the practice to cast cases several hours in advance of the time they will be required for use.

Molding presses operated by steam or hydraulic power are usually provided with devices for indicating the depth of impression made in the wax, or with automatic stops for shifting the belt when the impression

has reached a predetermined depth. Such devices are effective only when the wax cases are all of the same thickness and of uniform temperature. The temperature of the wax determines its degree of plasticity, and the suitable degree is indicated when the wax will yield under pressure of the thumb. The ability to judge the correct temperature comes with experience, and can be acquired in no other way.

By exercising due care to fill the cases level with the bearers which surround them, the waxcaster may produce cases reasonably uniform as to thickness; but to insure absolute accuracy they should be passed through a wax-shaving machine, which not only insures uniformity but also removes any dirt or dust which may have become attached to the wax while in a liquid or semi-liquid state.

When wax cases are cast several hours in advance of their use and have become cold and brittle, it is necessary, before molding, to restore them to a plastic condition, as any attempt to mold in cold wax would be not only dangerous alike to press and form, but would inevitably result in failure. The wax is sometimes softened by laying the cases on a steam-heated table, such as is illustrated in Fig. 8, first placing some strips of wood on the table to protect the back of the case from excessive heat. Unless so protected, the wax next the case would become much softer than the face, and the result of molding from a case thus unevenly heated would almost certainly be concaved faces in the reproduced type and cuts. Even when great care is observed in warming the cases, it sometimes happens that this defect occurs in the electrotype, and for this

reason as well as to avoid delay it is advisable to keep the cases in a box moderately heated by steam or hot air where they will be gradually brought to nearly the proper temperature for molding. They will then require an exposure of but a few moments on the steam table to make them sufficiently plastic. Instead

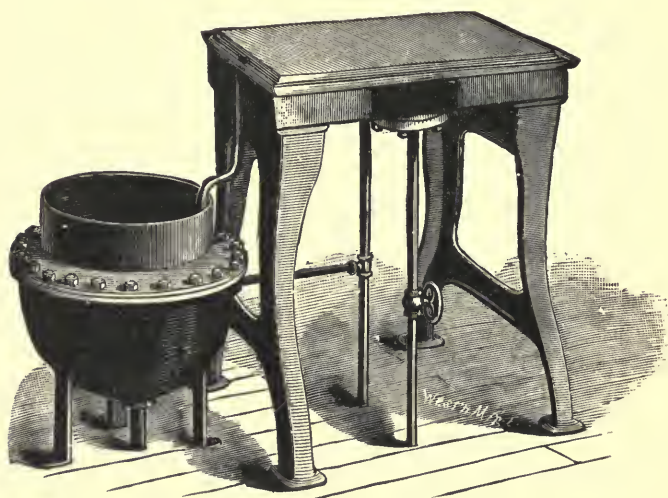


FIG. 8.

ELECTROTYPERS' WAX KETTLE AND TABLE.

of a box, a number of pigeonholes may be constructed about two feet above the steam table in such a manner that the cases may rest on their edges in a vertical position, and the hot air arising from the steam table permitted to circulate between them.

Having warmed the case until the wax will take an

impression of the thumb, it is given a thorough coating of molding graphite, which, when properly applied, prevents the wax from spreading. Graphite should also be applied to the form, rubbing it in thoroughly with a brush in order to prevent the type or cuts from adhering to the wax.

The form is now placed on the apron of the molding press and the case inverted upon it, or if the form is small the operation may be reversed and the form inverted upon the case. In either event two or three sheets of heavy strawboard should be placed between the back of the case and the press to prevent too sudden chilling of the wax. Having been thus prepared, the form and case with its strawboard backing are slid under the head of the molding press and pressure applied until sufficient depth of impression has been obtained in the wax, when the form and mold should be carefully separated and examined.

It will sometimes be found necessary to take a second impression in order to obtain a perfect mold, and in such cases it is obvious that the utmost care must be exercised to prevent a doubled impression. To provide for such contingencies, forms which are to be electrotyped should be imposed in such a manner as to leave an opening between the sections of furniture at two of the corners of the chase, that the molder, when setting the form the second time, may accurately locate the first impression.

When a large number of duplicates are required from one form it is customary to prepare a sufficient number of electrotypes to fill a chase and thereafter mold from the patterns instead of the original

form. When the patterns are carefully prepared no building will be required on the molds, and much of the labor of finishing will also be saved.

The operation of the molding press is sufficiently explained by the illustrations Figs. 9 and 10. With the exception of the hydraulic press the principle by

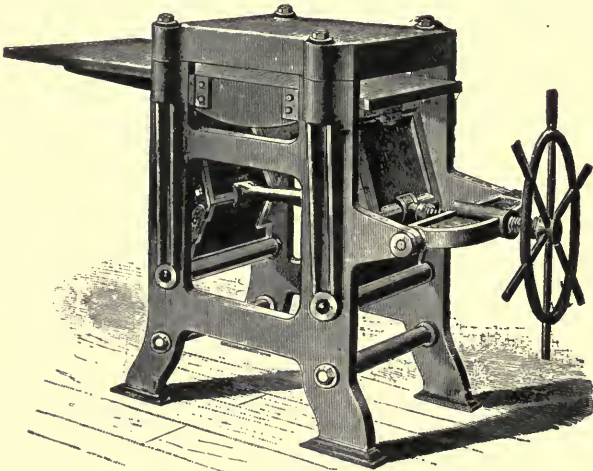


FIG. 9.

ELECTROTYPERS' HAND MOLDING PRESS.

which pressure is applied is the same in all molding presses — a toggle joint operated by a screw. In the hand press the screw terminates in a hand wheel whose spokes extend beyond the rim of the wheel to provide a convenient means of applying power. The screw in a power press terminates in a large gear wheel which is engaged by a pinion driven by steam power.

The press illustrated in Fig. 10 is provided with an indicator consisting of a finger and graduated dial, by means of which uniformity in depth of impression may be obtained. The indicator is particularly useful when two or more impressions are required, for, having noted the location of the finger on the dial plate at the

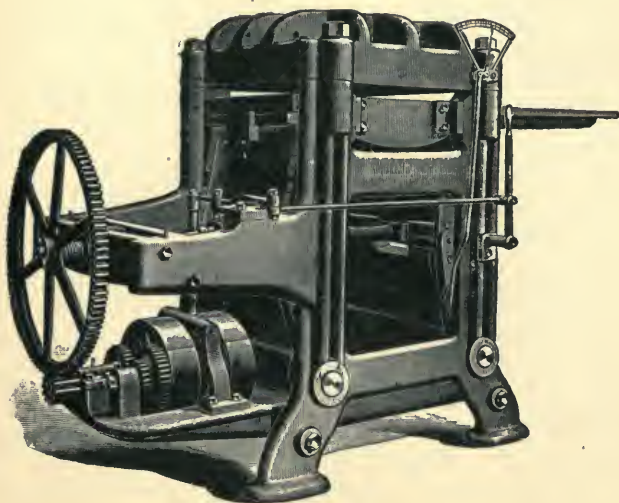


FIG. 10.

## ELECTROTYPERS' POWER MOLDING PRESS.

completion of the first impression, it is an easy matter to determine the depth of the second.

In connection with the operation of the molding press mention may be made of a fact not always recognized by molders, which is, that the greatest power exerted by a toggle joint occurs just before the toggles

reach a perpendicular position. The amount of packing placed under the case is sometimes so excessive that the toggles never reach the point of highest efficiency, and therefore more or less power is unnecessarily expended in producing the impression. While this is of no particular moment in the case of the steam press, except as it throws a heavy strain on the yoke, a proper adjustment of the packing would save considerable hard labor to the operator of the hand press.

## CHAPTER XI.

## BUILDING.

MOLDING a form or pattern naturally causes more or less displacement of wax, which is forced up around the edges of the form and between the cuts or type, or wherever there is an opening, however small. Before proceeding to metallize the mold, it is necessary that these displacements shall be cut down to a uniform level, for it would not only be difficult to metallize, by the usual methods, a mold whose surface consists of knobs and protuberances of uneven heights, but it would also be impossible to cast the electrotype plate within the limits of the thickness usually required for printing purposes, for every protuberance on the mold would necessarily involve a corresponding depression in the shell; and inasmuch as the shell must be backed with metal and entirely covered thereby, the thickness of the finished electrotype plate could not be less than the highest point of the shell. As a rule, electrotypes are made not more than one pica in thickness, and the lowest depression in the electrotype where blank spaces occur must obviously be somewhat less than a pica in depth.

For the purpose of cutting down the mold a wax knife (Fig. 11) of special design is employed. The mold and the knife should be warm, and the knife must be occasionally heated over a gas jet or stove. The displaced wax is removed by a shaving, outward cut of the knife, taking care not to cut too deep into the mold.



FIG. 11.—WAX KNIFE.

The operation requires some practice, but is easily accomplished if the knife blade is kept warm; otherwise there would be danger of breaking down, or distorting the walls of the cavities of the mold, in which case the later operation of blackleading or metallizing the mold would be rendered difficult if not impossible. Even a sharp, warm knife will leave the edges of the walls more or less ragged, but these edges may be rendered smooth and rounded by passing rapidly over the mold a lighted gas jet attached to a rubber hose.

After the cutting-down process, the operator should go carefully over the mold with a sharp-pointed tool and pick out any shavings or particles of wax which may have become lodged in the indentations.

The mold should now present a reasonably smooth surface, all the high places caused by displacement having been cut down to a uniform level, which leaves the indentations in the mold from  $\frac{1}{8}$  to  $\frac{1}{16}$  of an inch deep.

If the mold has been made from a solid type form, it may now be metallized and prepared for the depositing vat; but if made from an open form, the blanks between the printing surfaces must be raised in order to produce a depression in the electrotype and thus eliminate all possibility of smutting in printing. Unless the blank is raised or built up in the mold, it would be necessary to deepen the depression in the electrotype by routing or chiseling, which is a much more expensive operation than building, particularly when a number of duplicates are required from one pattern. Building is an operation requiring a steady hand and a quick eye as well as a skill which comes from long practice. The tools employed are a building iron (Fig. 12), a small gas stove



FIG. 12.—BUILDING IRON.

and a strip of wax. The building iron is a smooth, cone-shaped block of copper, about two inches long, one inch in diameter at one end and tapering to a sharp point at the other, with a handle eight or ten inches in length inserted in the side. Several of these irons should be provided in order that while one is in use the others may be heating. To build up a blank in the mold, the operator takes a hot iron in one hand and a strip of wax in the other, and, holding the point of the iron over and close to the blank which is to be raised,

touches the iron lightly with the strip of wax, which instantly melts and runs down the iron onto the mold. If the blank is large, the wax is held in contact with the iron while it is moved over the space back and forth until entirely covered and built up to the required height.

Care must be taken not to get the iron too hot, for in that case the wax would be made too thin and would not chill quick enough by contact with the mold, but would run off from the blank and into the indentations of the mold. It is always advisable to test the heat of the iron by running some wax onto the edges of the mold where no damage can result. Before blackleading or metallizing the mold it is also necessary to provide places of contact for the electrical connections. This may be done in various ways. The simplest method is to provide two pieces of copper wire, about  $\frac{3}{16}$  of an inch in diameter and six or seven inches longer than the case. One end of each wire should be turned over to form hooks by means of which the case may be suspended from the cross rods of the depositing vat. The wires are heated by dipping them in the metal pot or in any convenient manner, and are then laid on the case, one on each side of the mold, where they become embedded by melting a channel for themselves in the wax.

Additional security is obtained by covering over the wires with wax by means of the building iron. This method of providing electrical connection with the mold is simple and reasonably secure, if the case is not too heavy; but a better method consists in substituting for the wires strips of thin sheet copper from one-half to one

inch in width. These strips are not designed to sustain the weight of the case, but simply to act as conductors, and for this purpose are superior to wires, because they assure a better contact with the cross rods. When this connection is employed, the weight of the case is sustained by S-hooks, one end of which is passed through a hole in the case, and the other end, which should be insulated, hooked over the cross rod.

There are several other methods of making electrical connections with the molds which are valuable chiefly as time-savers. One of them is shown in the illustration. A piece of copper or brass is melted into the mold near the top and makes contact with a portion of the hook which suspends the case from the cross rod of the bath.

## CHAPTER XII.

## METALLIZING.

THE utility of electrotyping in its early days was restricted to the reproduction of medals or other metallic objects which were conductors of electricity, but in 1840 Mr. Murray discovered that nonmetallic objects could be made conductive by applying to their surface a film of graphite (blacklead), and to this discovery is largely due the successful application of electrotyping to the copying and duplication of engravings and type forms. Only the purest grades of graphite containing from 95 to 99 per cent of carbon are used for metallizing. For this purpose it is ground to a seemingly impalpable powder, but under the microscope it is found to consist of minute flakes. To metallize or render conductive a nonmetallic object, it is essential that these flakes shall lie flat upon it like the scales of a fish, overlapping each other and forming a continuous and unbroken metallic covering for the object. Such a surface can be obtained only by brushing or otherwise forcing the flakes into the position described, which will incidentally give to the object a bright polish. Black-leading is sometimes accomplished by means of a pump

or air blast, as will be hereafter described, but the usual method is to apply the graphite with a soft brush of camel's or badger hair, either by hand or with a blackleading machine. For blackleading by hand a camel's-hair brush is preferred. With this instrument the graphite is brushed back and forth over the mold until a bright polish is obtained, and until it is certain that no spot, however small, has been neglected. If so much as a punctuation point fails to receive the proper polish, copper will not deposit thereon, and a hole in the shell will result.

Blackleading by hand is a slow and disagreeable task, and is seldom practiced in American foundries, a blackleading machine being considered essential even in the smallest establishments. Fig. 13 illustrates a blackleader which is a type of the machines in general use at the present time. While there are variations in the mechanical movements of different machines, the essential features are a vibrating brush or brushes, and a reciprocating bed to carry the molds back and forth under the brushes. The apparatus is all inclosed in a tight box which confines and prevents waste of graphite. After the mold has been built up and prepared as previously described it is placed on the bed of the blackleader and covered thickly over with graphite. When the machine is started the molds travel slowly back and forth while the rapidly vibrating brushes soon effect the necessary polish. The time required to properly blacklead a mold depends upon the nature of the work and the speed at which the brushes are operated.

A mold of a type form requires considerable more brushing than a flat engraving because of the minute

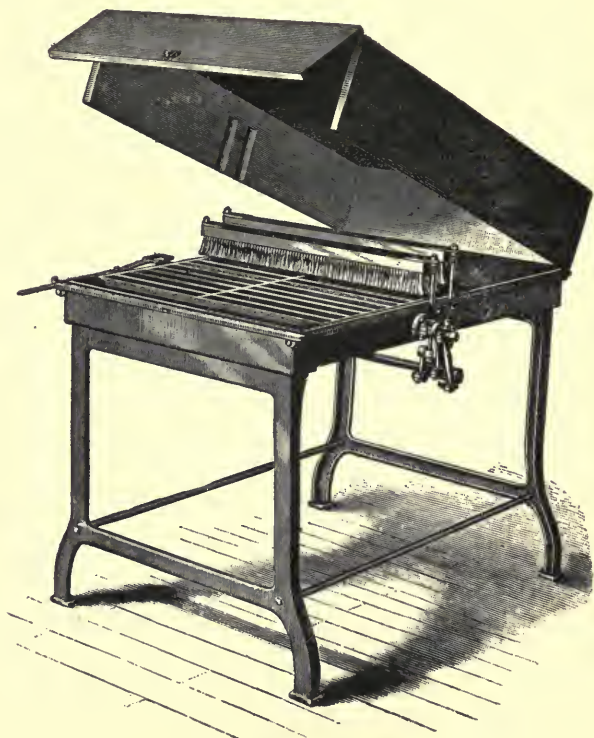


FIG. 13.—BLACKLEADER.

indentions made by the punctuation points, etc. With a double-brush machine running at about 600 revolu-

tions per minute, a good polish is usually obtained in from five to ten minutes.

A disagreeable feature of blackleading is the flying dust, which cannot be wholly confined and which eventually covers everything in the molding room, including the workmen. This annoyance is minimized by the use of the inclosed blackleading machine but not entirely eliminated. On this account the wet process of blackleading is sometimes preferred. This method was invented and patented by Mr. Silas P. Knight in 1872. By this process the graphite is mixed with water to the consistency of thin cream and by means of a rotary force pump is discharged with considerable force upon the mold through a traveling rose nozzle, the entire apparatus being confined in a water-tight box. In another form of wet blackleader the emulsion of graphite is forced over the mold by a paddle wheel which revolves in the liquid. The blades of the wheel consist of badger-hair brushes which come lightly in contact with the mold and assist in producing the necessary polish. The wet process is said to be entirely satisfactory, but for some reason has never come into general use.

Various attempts have been made to perform the operation of blackleading by means of a blower or air blast, and several patents have been issued for machines with this design. Fig. 14 illustrates a machine which combines both the air-blast and brush features. Air from the pressure blower (on the floor, back of the machine) passes through tubes in the horizontal cylinder (above the machine) and is discharged through a narrow

slot extending across the table and close to the mold ; water circulating outside the tubes reduces the tempera-

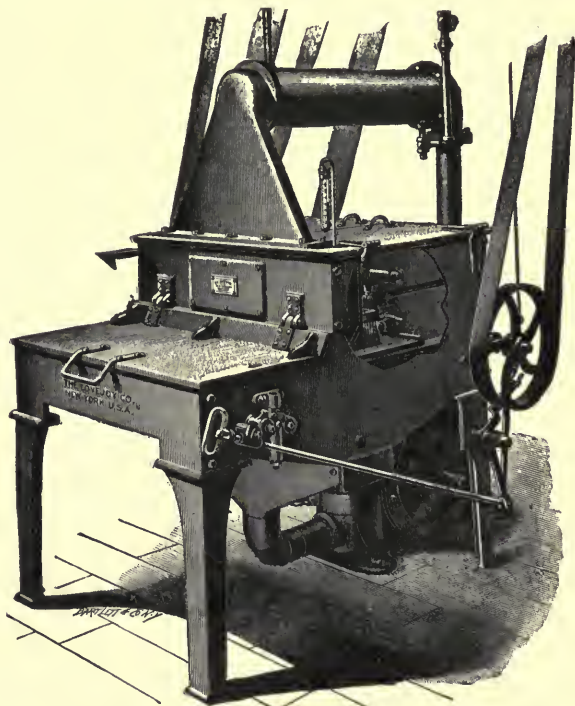


FIG. 14.—COMBINATION BLACKLEADING MACHINE.

ture of the compressed air, so the machine may be operated continuously—even in the summer—without danger of injury to wax molds. At the bottom of the

machine there is a shallow drawer with a gauze bottom through which the air passes to the blower ; the gauze retains particles of wax and other substances likely to obstruct the free passage of air through the slot. However, should the slot become clogged, by removing the plate on the front of the machine the workman can obtain access to the wind chest and may easily clear away any obstruction. By a glance at the mercury gauge, on the top of the machine, the operator can see whether the air pressure is as it should be. The brush, which is of badger hair, is located just back of the wind chest and actuated from a shaft supplied with a tight pulley, so, whenever desired, the brush may be stopped. The distance of the brush from the table is adjustable.

In operation the workman lifts the cover, at front, which is held raised by a hook shown at the left side, lays the cases to be leaded on the table, which is 33 by 22 inches, lowers the cover, and starts the machine by pulling the handle on the right until a pawl drops into a notch in the rod ; he then adjusts the stop motion so the table will make one, two or three trips forward and back ; when these have been completed the pawl will be detached automatically from the rod, and the spring on the countershaft carry the belt on the loose pulley, stopping the machine. It is claimed by the manufacturers that a tableful of molds may be metallized in one minute.

After the mold has been blackleaded, it must be thoroughly freed from the loose graphite which would otherwise remain in the depressed portions, particularly

in the smaller indentations made by punctuation points and leaders, and cause defective shells. The removal of the superfluous graphite may be effected by a hand bellows, but in large establishments a rotary fan operated by power is sometimes employed. A still better method consists in taking the air through a tube from a reservoir in which it has been compressed by an air pump. By this method sufficient pressure to thoroughly blow out the mold is assured. From such a reservoir additional tubes may be extended to the molding presses, and utilized to blow the loose graphite from the molds as may be necessary during the operation of molding.

By the process of blackleading, the case is rendered conductive over its entire surface, and should it be suspended in the bath without further preparation, it would receive a deposit of copper not only upon the mold but upon the margin of wax surrounding the mold, and upon the back of the case. To restrict the action of the current to the surface upon which a deposit is desired, the remaining portion is painted out with hot wax or varnish, or its conducting surface is destroyed by passing lightly over it a hot building iron. The conductivity of graphite is only .07 of one per cent as compared with pure copper, 100 per cent, and the action of the electric current on a blackleaded mold is therefore very slow until covered with a coating of copper, when deposition proceeds rapidly. To give the mold a better conducting surface than is provided by the graphite, and thus facilitate immediate action of the

current over its entire surface, it is customary to precipitate a film of copper on the mold before placing it in the bath. This preliminary coating of copper is produced by pouring on the mold a solution of sulphate of copper of about 16° Baumé, and covering it with a sprinkling of iron filings. With a badger-hair brush the filings are lightly distributed over the mold until thoroughly wet, when they take up the acid in the solution, and the copper thus set free is precipitated in a bright film on the mold. If any portions of the mold fail to take the coating the operation is repeated. Particular care is observed to avoid scratching the mold with the iron filings.

Flat molds such as are made for the production of copper printing plates may be readily and effectively metallized by either of the methods previously described, but for the production of nickel electrotypes or the reproduction of irregular shaped objects such as statuary, or art work of various kinds having undercut or deep portions, recourse must be had to what is called metallizing by the wet way. While this class of work is not strictly in the line of commercial electrotyping it is sufficiently analogous to deserve mention. The processes to be described are recommended by such practical writers as Langbein, Urquhart and Watt. Gutta-percha or wax molds have their surfaces rendered conductible by the following plan: Take equal parts of albumen (white of egg) and a saturated solution of common salt, and apply the mixture to the object to be coated by means of a soft brush. Then dry the compo-

sition thoroughly. Now make a strong solution of nitrate of silver and dip the mold into it for a few minutes and dry again. Expose the mold to a strong light until it becomes quite black. The mold is then to be dipped into a saturated solution of sulphate of iron, when a layer of metallic silver will be formed upon which a deposit of copper may readily be obtained. The mold should be rinsed when taken from the sulphate of iron solution and connecting wire attached to it, when it may at once be placed in the depositing bath.

Another method of metallizing is as follows: Dissolve a piece of phosphorus in two drams of bisulphide of carbon, stir in two drams of benzine and a drop or two of sulphuric ether; pour the whole into half a pint of alcohol and wash the surface of the mold with this mixture twice, allowing it to dry after each application.

The silver solution is made by dissolving one dram twenty grains of nitrate of silver in a mixture of half a pint of alcohol and one dram of acetic acid. The mold is thoroughly floated once with this solution and allowed to dry spontaneously.

Another and simpler method of rendering the mold conductive may be described as follows: Dissolve phosphorus in pure alcohol until a strong solution is obtained and wash the mold with the mixture. The silver solution is prepared by dissolving nitrate of silver in aqueous ammonia to saturation. It is to be poured evenly over the mold and allowed to float over it for a few minutes. The solution is poured off and

the mold allowed to become partly dry, when it is again floated with the mixture. Spots that do not appear to take the solution readily should be wetted with it by means of a soft brush.

Still another process is as follows: Apply with a brush upon the mold a not too concentrated solution of nitrate of silver in a mixture of equal parts of distilled water and ninety per cent alcohol. When the coat is dry, expose it in a closed box to an atmosphere of sulphureted hydrogen. The latter converts the nitrate of silver into sulphide of silver, which is a good conductor of the current. For the production of the sulphureted hydrogen, place in the box, which contains the mold to be metallized, a porcelain plate or dish filled with dilute sulphuric acid (1 acid to 8 water) and add five or six pieces of iron pyrites the size of a hazelnut. The development of gas begins immediately and the box should be closed with a well-fitting cover to prevent inhaling the poisonous gas; if possible, the work should be done in the open air or under a well-drawing chimney. The formation of the layer of sulphide of silver requires but a few minutes, and, if not many molds have to be successively treated, the acid is poured off from the iron pyrites and clean water poured upon the latter so as not to cause useless development of gas.

For coppering leaves, plants, flowers, etc., dissolve five parts (by weight) of wax in five of warm oil of turpentine, and add to the solution a mixture of five parts of phosphorus, one of gutta-percha and five of asphalt in 120 bisulphide of carbon. When both are

thoroughly mixed, add to the whole a solution of four parts (by weight) of guncotton in sixty of alcohol and sixty of ether, and, after a thorough shaking, allow to settle. The next day pour off the clear solution from the sediment, when the solution can at once be used.

A French process for metallizing leaves, etc., consists in immersing them in iodized collodion composed of forty per cent alcohol, 40 cubic centimeters; ether, 60 cubic centimeters; potassium iodide, 1 gram; guncotton, 1 gram. Allow the leaves, etc., to dry so that a firmly adhering layer is formed; then immerse them in a solution of ten parts (by weight) of nitrate of silver in 100 of water, whereby a layer of iodide of silver is formed. Now expose the article thus treated for some time to the light, and then immerse it in the reducing fluid consisting of water, 500 parts; green vitriol, 25 parts, and acetic acid, 25 parts. The reduction of silver proceeds rapidly and the articles are soon ready for coppering. Instead of the iodized collodion, a mixture of equal parts of white of egg and solution of common salt may be used.

## CHAPTER XIII.

## THE CONDUCTORS.

THE electrodes and all connections between the dynamo and the molds or anodes should be of copper and should be amply large to conduct, without heating, the strongest current practicable to use in the depositing process. It should be remembered that the generation of the electric current requires power, and that a portion of the power is always expended in overcoming resistance, and is, so far as its effect on the work is concerned, wasted. It is obvious, therefore, in the interest of economy, that due precaution should be observed to provide both in the conductors and in the bath a path of minimum resistance. A barrel of water would run out of an inch bung-hole in a very few minutes, while it would take a tremendous pressure to force the same quantity of water in the same time through a gimlet hole. In the same way a current of several hundred amperes will flow readily through a large rod, when the attempt to force the same current through a small wire would result in overheating the wire and the dynamo, with a consequent waste of power. "The development of heat in the conductors or the solution is proportional to its resistance and is proportional to the

square of the strength of the current. Hence, the development of heat will be the greater, the smaller the cross-section of the conductor and its conducting capacity are, and the larger the quantity of current which passes through it."

The size of the conducting rods required for electrotyping depends, therefore, on the quantity of current to be employed at one time, which may be estimated with sufficient accuracy by multiplying the area of the cathodes in square feet by the number of amperes required to deposit one square foot at the maximum practicable rate. Curiously enough there is a wide divergence of opinion among authorities as to the quantity of current which may be advantageously employed. V. Hübl gives the maximum as 36 amperes with an agitated solution. Sprague and Watt place the maximum at 37 amperes, while other writers claim that from 75 to 100 amperes may be employed. It is probable, however, that the latter estimates are made without considerations of economy. It would no doubt be possible to employ 100 amperes, but at a tremendous waste of power in overcoming the resistance due to polarization, which increases "at a rate approaching that of the square root of the current." It is probable that 50 amperes per square foot cannot be exceeded, if consideration be given to economical working.

Depositing vats vary in dimensions, and for that reason a conducting rod which would be of ample capacity in one case would be too small in another. Inasmuch as the difference in the cost between a small

rod and a large one is inconsiderable, it is always wise to err on the side of safety. The text-books recommend a cross-sectional area in the conductor of one square inch for each 500 amperes, and in practice, rods of this size have been found to be of ample capacity. The resistance of a conductor is proportional to its length as well as to its cross-sectional area, and this rule applied to electrotyping means that the dynamo should be located in the immediate neighborhood of the depositing vats. For the purpose of conducting the current, the cross rods, i. e., the rods from which the anodes and molds are suspended, do not usually require to be more than one-fifth the size of the main conductors, but inasmuch as it is their province to sustain the weight of the heavy anodes they should not be less than one-half inch in diameter.

Less trouble will be found in making good connections if the main conducting rods are rectangular in shape, as in that case the cross rods which rest upon them will have a larger area of contact surface, particularly if the ends are slightly flattened. If the main conductors are round, the ends of the cross rods should be not only flattened but curved to fit over the larger rods, and thus insure a good contact. The anodes are usually suspended in the solution by two copper hooks, which should be large enough to transmit the current without becoming sensibly heated—say three-eighths of an inch in diameter. These hooks, like the cross rods, should be flattened and curved in order to insure ample contact surface. Undoubtedly the best method of

suspending the anodes is to drill and tap holes in the ends and screw the suspending hooks into them. This makes a perfect connection, and will remain as long as the anodes last.

It has been frequently noted that electrotypers do not always appreciate the importance of making good connections. It is of no avail to provide large conducting rods and cross rods if the conducting capacity of the rods is to be choked off at the point of connection, which is what occurs when one round rod is laid across another round rod. It should be plainly obvious that unless one or both of the rods are flattened where they come in contact, the area of the contact will be extremely limited compared with the area of the conductors on both sides of the contact. It is hardly necessary to say that all contact points should be kept clean and bright. A neglected rod will soon become corroded, and corrosion increases resistance and is a frequent cause of heat.

It should not be forgotten that the solution is a conductor of the current in the same sense that the rods are, and should be considered in that capacity as well as a dissolving medium. Pure sulphate of copper solution is an extremely poor conductor. The addition of sulphuric acid improves its conductivity, but under the most favorable conditions its resistance is several million times greater than copper. To reduce this resistance to a point where the solution will not become appreciably heated by the passage of a strong current it is necessary to provide an exceedingly large area of conducting fluid and to suspend the anodes and cathodes

as near together as possible, say two to three inches apart. According to Joule's law, previously quoted, the development of the heat will be the greater the smaller the cross-section of the conductor and its conducting capacity are, and the larger the quantity of current which passes through it. If, therefore, it is desired to employ a very strong current, the vats must be larger in proportion to the size of the anodes than would be necessary with a moderate current. It is safe to say that the cross-sectional area of the solution should be at least double the area of the anodes.

## CHAPTER XIV.

## DEPOSITING.

WHEN a mold has been metallized by the dry graphite method, and before proceeding to strike it (i. e., precipitate on its surface a preliminary coating of copper to render it more conductive), it is essential that the air shall be expelled from its surface by thoroughly wetting it, otherwise the mold when first immersed in the bath will be apt to repel the liquid, and the film of air retained on its surface will partially insulate the mold and cause holes in the shell. Wetting may be accomplished by pouring over the mold a small quantity of alcohol or wood spirits. A more economical method consists in placing the mold face up on a shelf in a tank partially filled with water in such a manner that it will rest an inch or two under the surface, and then by means of a rotary pump and a rose nozzle direct a stream of water upon it. In some foundries graphite is mixed with the water, in which case the apparatus becomes an auxiliary blackleader and aids in the metallization of the mold.

After wetting and striking the mold it should be immediately suspended in the bath from one of the rods connected with the negative pole of the dynamo or bat-

tery. It will be recalled that the current enters the bath through the positive electrode and leaves it through the negative. It is obvious, therefore, that were the mold suspended from the positive rod no action would result.

The anodes are solid plates of rolled copper of any convenient thickness, but they should have as nearly as possible the same area of exposure as the cathodes. If the anode be much smaller than the cathode the deposit will be brittle and the solution become impoverished. If the anode should be much larger than the cathodes copper will be dissolved faster than it is deposited, increasing the density of the solution and resulting in streaks on the back of the electrotype and the formation of uneven deposits.

Holes in the shell are usually due to defective black-leading or failure to expel the air from the mold by thorough wetting. In some instances, however, they are caused by hydrogen bubbles. The remedy for the latter evil is to decrease the current strength or pass a camel's-hair brush lightly over the mold several times during the time it is in the bath, or, better yet, agitate the solution.

The mold should be examined after it has been in the bath a few minutes, and if any dark spots are observed it should be at once removed and a solution of graphite and water, or, better yet, graphite and alcohol, should be thoroughly rubbed into the defective spots. The mold should then be rinsed under a strong head of water applied through a spray nozzle and

returned to the bath. On no account should the mold be allowed to dry while out of the bath.

The anodes should, of course, be suspended from the positive pole of the dynamo, and it is evident that only one anode need be provided for each pair of cathodes, for, to maintain an equal area of exposure, a mold should be placed on each side of the anode.

If the baths are arranged in series, which is the most economical method of working, the total number of molds should be divided as evenly as possible between the vats to insure an equal rate of deposition.

The copper sulphate solution requires little attention as a rule, because the proportions of its ingredients may be quite widely varied without materially affecting the quality of the deposited copper, and, on the other hand, the current strength may also be varied and the quality of the production still remain satisfactory; but, notwithstanding these facts, it is possible to make the solution too rich or too poor in metal, or too weak or too strong with acid, and the current density may be too great to work in harmony with the solution. Very often a defective shell may result from one of two or three causes. It is, therefore, sometimes necessary to experiment a little in order to determine the exact cause of the trouble. For instance, a sandy, pulverulent deposit may be caused by an excess of current, or it may be caused by an excess of metal in the solution, or both. A brittle deposit will be caused by a weak current, or a solution poor in metal, or both. But if the electro-typer be provided with an accurate voltmeter it is a

comparatively easy matter to locate the cause of the trouble, for if the instrument indicates a current of suitable tension for a properly proportioned solution, it may be assumed that the cause of the defective deposits will be found in the bath and may be removed by enriching or diluting the solution as may be indicated by the character of the deposited copper.

Under ordinary conditions of current and solution, the molds should be separated from the anodes by a distance of about two inches; but if it is found that the deposit is very dark in color or granulated in texture, this distance may be increased, thereby increasing the resistance of the solution, which is equivalent in its effect to cutting down the current strength.

After working a few hours the anodes become more or less coated with slime, consisting of impurities and small quantities of foreign metals, which are always present to a greater or less extent in rolled copper. To remove the slime, which has the effect of partially insulating the anodes, they should be removed from the bath once every day and thoroughly scrubbed and rinsed with clean water.

When molds are removed from the bath the anodes should always be disconnected from the dynamo, as otherwise copper would be dissolved into the solution, thereby unduly increasing its density.

The length of time required to deposit a shell of given thickness depends on the current-strength employed and the condition of the solution and connections. According to Gore, a current density of 17.94

amperes per square foot will deposit .001 inch of copper per hour; 35.88 amperes will deposit .002 per hour, and so on. Having ascertained the current-strength available there would be no difficulty in calculating the time necessary to obtain a deposit of any required thickness provided it were certain that no variation in the current would occur, and that the connections would remain clean and in perfect contact, for having once ascertained the time required to deposit a satisfactory shell, it would be safe to assume that the same results would be obtained thereafter; but carelessness in the preparation of molds, as well as dirty rods or connections, sometimes delays the action of the current, and the electrotyper, after the calculated time, usually separates one corner of the shell from the mold with a sharp-pointed tool, and tests its thickness by bending it back and forth. This would seem to be a "rule-of-thumb" method of working, but constant practice makes the workman so expert that he seldom makes a mistake. In establishments where the volume of work is large, it is customary to provide time tags which may be attached by clothes pins or other devices to the molds or cross-rods. When the mold is suspended in the bath, a tag is attached on which is written the hour it is due to come out. In this way the electrotyper is enabled to keep tab on his work and avoids waste of time in testing work which has been insufficiently exposed; for while it sometimes happens that a longer time is required to deposit a shell than would be indicated by the voltmeter or ammeter, it never takes less than the time so indicated.

The electrotypers' sink should be of ample dimensions and should be provided with an unlimited supply of hot and cold water. The cold water faucet should be a hose bib, to which should be attached a short piece of hose terminating in an adjustable nozzle, to provide either a spray or a strong stream of water as circumstances may demand. The hot water should be kept in a tank at one end of the sink, from which it may be dipped as needed. One end of the sink should be provided with a hinged apron to protect the operator and the floor from the spray when using a strong head of water such as is necessary in washing out molds.

## CHAPTER XV.

## CASTING.

ELECTROTYPERS' furnaces were formerly constructed of brick with an iron kettle and face plate. These furnaces are, however, seldom seen now, the modern furnace (Fig. 15) being constructed of iron, lined with fire brick. It occupies less room than the old style furnace, is set up several inches from the floor to provide an air space underneath and thus minimize the



FIG. 15.—ELECTROTYPERS' FURNACE.

- danger from fire, and it may be moved from one place to another when desired without tearing it to pieces. The kettle is square or oblong in shape, for convenience in floating the backing pans, and is about six inches

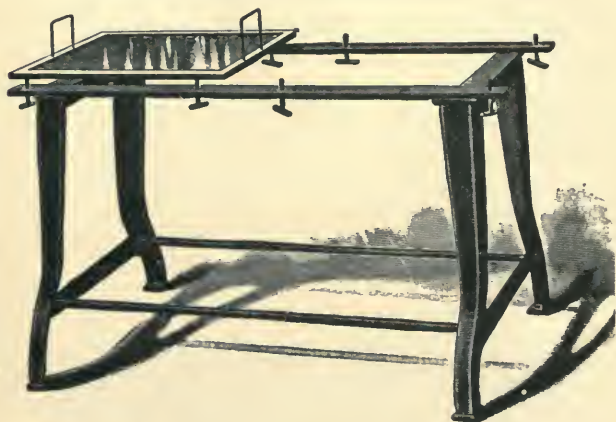


FIG. 16.—LEVELING STAND.

deep. A wide flange or shelf extends around the top of the furnace to provide a convenient resting place for the backing pans and body molds. The floor under the furnace and for some distance in every direction should be covered with heavy sheet iron, about No. 16 gauge.

The leveling stand (Fig. 16), upon which the backing pans rest while the cast is poured, is a light but substantial framework of iron, whose upper rails are provided with T-screws which may be so adjusted as to

keep the pan always in a level position and thus insure a cast of uniform thickness.

The backing pan (Fig. 17) is a plate of iron or steel, planed perfectly true and surrounded with a raised edge whose height determines the thickness of the cast. The pan is provided with handles to facilitate handling. Where the pans are large it is customary to handle them by means of a crane with an arm of sufficient length to swing them from the furnace to the leveling

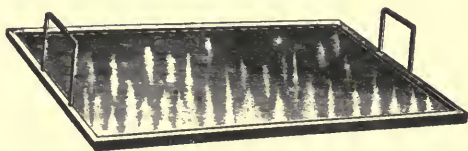


FIG. 17.—BACKING PAN.

stand. Backing pans should always be kept perfectly clean, and to that end should be scoured after each cast. Unless they receive proper attention in this respect they will soon become rusted and totally unfit for the purpose for which they are designed; for to assure a perfect cast it is essential that the shell shall lie perfectly flat upon a smooth and level surface.

Backing metal is composed of lead, tin and antimony. A popular mixture is lead 90 pounds, tin 5 pounds, antimony 5 pounds. However, the proportions of tin and antimony are sometimes varied. Some electrotypers prefer 4 pounds of tin and 6 of antimony, and others 6 pounds of tin and 4 of antimony. The

requirements are that the metal shall be soft enough to straighten easily under the hammer and punch, yet not so soft as to crush down on the press, and it must contain tin in sufficient quantity to insure perfect adhesion of the metal to the copper shell.

Having deposited a shell of satisfactory weight, the mold is removed from the bath and placed in the sink in a slanting position. After cutting the connections, a small quantity of hot water is poured over the mold, beginning at the upper end and allowing it to flow down over every portion of its surface. The heat softens the wax and releases the shell, which should be carefully handled to prevent buckling or bending. After rinsing the shell in cold water it should be washed with hot potash to remove the film of wax which will still adhere to the copper. The shell may be placed on a slanting board over the lye kettle and scrubbed lightly with a soft brush, and then rinsed with potash and afterward with clean water. Unless the shells are to be immediately backed up with metal, they should be placed in a shallow, lead-lined box partially filled with water slightly acidulated with sulphuric acid. If the shells are permitted to become dry they will tarnish and will not readily amalgamate with the backing metal.

In order to effectually unite the backing metal to the shells it is essential that the back of the shell shall be perfectly clean, and that it shall be first covered with a coating of solder or with tin foil, which becomes solder when mixed with the lead in the backing metal. Tin foil may be purchased in rolls of any desired width

and thickness. A convenient size is five or six inches in width and about .002 inch in thickness.

To thoroughly clean the shell it should be brushed over with a solution of chloride of zinc, which may be prepared by dissolving scraps of sheet zinc in muriatic acid to saturation and adding twenty-five per cent pure water. The zinc should be dissolved in a wide-mouthed bottle in the open air, as the fumes given off are disagreeable and poisonous. The zinc solution may be applied with a bristle brush, and the operation may preferably be performed on a glass-topped table or on a sheet of heavy plate glass placed on the workbench. Glass is preferred because it is not affected by acid and may be easily kept clean.

After cleaning with the tinning solution the shell is covered with tin foil and placed face down in the backing pan, which has been previously heated by floating it in the molten metal, whose temperature should be sufficiently high to scorch a piece of white paper without burning it. The tin will almost immediately melt and cover the shell with a thin coating. If preferred, the shell may be placed on an iron plate heated by gas instead of in the backing pan, the object being to melt the tin foil on the shell. After the tin is melted the backing pan should be immediately transferred to the leveling stand and the shells covered with molten metal, pouring it on slowly from a small ladle and holding the shell down with a stick or any convenient instrument if it shows any inclination to rise to the surface of the metal.

To expedite cooling of the cast a small blower may be placed on the floor under the leveling stand in such a manner that a stream of air may be directed against the bottom of the pans.

A device which is sometimes employed in connection with the backing-up process and which is claimed to

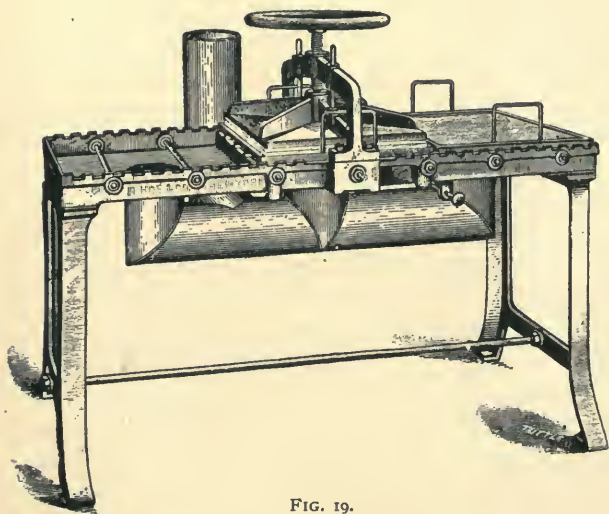


FIG. 19.

accomplish a material saving of time and labor is illustrated in Fig. 19. The description is taken from the circular of the manufacturer.

The apparatus is designed to flatten the plates by pressure after the metal has been poured and before it has set and hardened. The process differs but little

from that hitherto employed, the new feature being the application of pressure, whereby much of the hammering and finishing is obviated.

The press has been so designed as to make it thoroughly efficient and convenient, many suggestions from experienced electrotypers being embodied in its construction. Its operation is very simple, presenting no difficulties.

When the pan is lifted out of the metal pot the metal that adheres to the bottom of the pan is scraped off by a steel scraper attached to the front end of the press. On the inner sides of the frame of the press are rollers, seven on each side, upon which the pans move easily and quickly. The pan is set on the rollers on the front of the press and the shell backed as usual. Air is blown on the bottom of the pan from a pipe underneath, and on the metal from a pipe above, the object being to cool the cast evenly as well as quickly. When the metal has commenced to set, a sheet of thick asbestos, covered with powdered chalk or blacklead, is laid on top of it and the pan rolled under the platen. The blast is then turned on the bottom of the pan under the platen. The rollers under the platen are on springs, and depressed by the pressure on the pan until the pan rests on supports underneath. The asbestos and the rollers being elastic, the pressure is gradual and easy. The pan remains under pressure till the next one is ready, and is then pushed out to the back of the press and taken off. The blast pipes underneath are supplied with the press and provided with dampers.

They are so arranged that connection can be made with the pipe from the blower on either side of the press.

Electrotypes are usually mounted on wooden blocks to make them "type high," but for certain purposes it

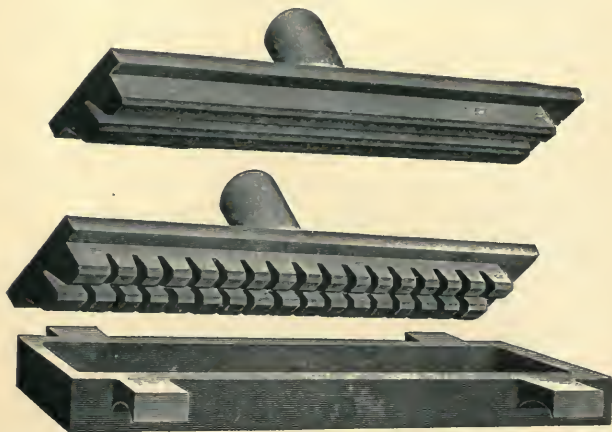


FIG. 20.

is desirable to mount them on metal bases, as, for instance, half-tone cuts and matter which is to be stereotyped, such as advertising cuts for daily newspapers. For the latter purpose electrotypes are made in standard widths, i. e., single, double or triple column.

The electrotype, after it has been backed up and straightened, may be tacked or soldered to metal bases which have been previously trimmed and shaved to the proper dimensions, but better results are obtained both in appearance and security by casting the base directly

on to the plate by placing the electrotype face down in an iron mold and pouring molten metal on the back. The cover of the mold is provided with corrugations which form depressions in the metal, thus effecting a saving in material and at the same time producing a cast both light and strong and more easily handled than a solid metal cast.

Figs. 20 and 21 illustrate respectively a body mold and a section of a cast made therein. The bottom plate of the mold on which the electrotype rests is not shown.

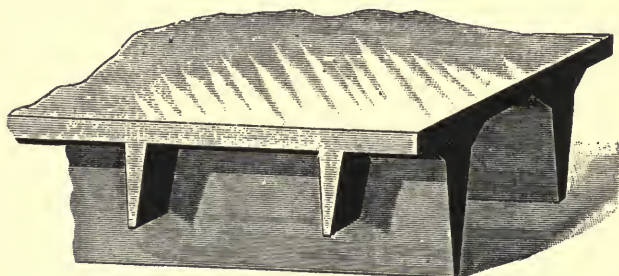


FIG. 21.

Before making a cast all parts of the mold are floated in the metal pot until they are of uniform temperature with the metal. With a pair of pincers or tongs the bottom plate is then withdrawn from the metal and placed on two supporting blocks, one under either end, one of which is slightly higher than the other, so that the plate will have a pitch of about one-half inch. The frame of the mold is then laid on the bottom plate, the electrotype placed inside, the cover adjusted and the

different parts clamped together with two iron hand clamps. The cover is somewhat shorter than the frame, which leaves an opening at the upper end to receive the metal. The temperature of the mold is sufficient to soften the backing of the electrotpe, so that the new metal, which is poured slowly and cautiously, readily amalgamates with it. Having filled the mold, the cast may be cooled by swabbing the mold with cold water. As the metal cools it shrinks and more metal must be continually added until the cast is set.

Electrotpe body molds are made in several standard sizes, from 6 to 41 picas in width and about 14 inches long. Electrotypes wider than 41 picas are cast in adjustable molds, an illustration of which is shown in Fig. 22. In such a mold electrotypes from one-half to four columns in width may be cast solid or cored. Eight cores of different sizes are usually provided, suitable for different kinds of work.

In some foundries the mold is cooled after the cast has been poured by partially immersing it in a tank of water. When employing this method it is important that the cooling shall be effected gradually, otherwise uneven shrinkage would result and the electrotpe be injured or destroyed. A convenient means of handling the molds is by means of a small derrick which may be locked in any desired position and thus permit the gradual immersion of the mold in the water.

After the shell has been backed up, the cast is taken to the scrubbing trough and thoroughly cleaned with kerosene and powdered pumice stone applied with a

moderately stiff brush, and finally polished and dried with soft sawdust. Great care should be observed in cleaning half-tones, as a slight scratch is sufficient to ruin them.

The backing pan will usually accommodate several shells, and after they have been cast and cleaned the

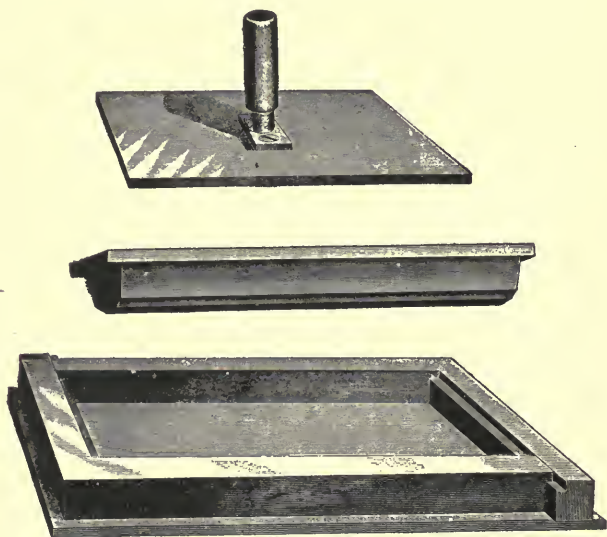


FIG. 22.

next operation is to saw the different jobs apart that they may be separately straightened and finished. For this purpose an iron saw table is employed, of which Fig. 23 is an illustration. The mandrel is driven by a countershaft and pulleys which are furnished with the

machine. The rear end of the table is hinged to the frame of the machine; the front rests on the end of a screw, terminating in a hand wheel, by means of which the top may be adjusted to any desired height for sawing mortices, etc. An adjustable side gauge and a sliding end gauge are necessary features if the saw is to



FIG. 23.

be used for general work, and a glass saw guard for protecting the eyes of the operator from flying chips and sawdust is also essential.

Saw blades for cutting electrotype metal should have about the same temper as for sawing wood, and should not be of greater diameter than the nature of the work demands. A large saw is liable to wind and warp, while, on the other hand, if it projects but slightly through the work this tendency will be minimized. The diameter of the saw must depend, of course, upon the distance between the saw mandrel and the table top. For instance, if the saw mandrel is three inches below the top of the table, a nine-inch saw would be required to give sufficient cutting surface above the table and allow for a reasonable amount of wear. In most machines, however, the mandrel is located within two and one-half inches from the top, or even less, thus permitting the use of smaller blades. For general use a cross-cut saw, eight inches in diameter, No. 18 or 19 gauge, and with about five points to the inch, is found most practical and convenient. Such a saw should be driven about 4,000 revolutions a minute.

To cut freely without sticking or filling up, saws should be kept sharp, round, evenly set, and the teeth should be filed all with the same angle and without hook. To keep the saw round, it should be jointed occasionally by elevating the table top until only the longer teeth of the saw project through the slot in the top, when they may be ground down with a piece of emery stone to uniform length. If the saw mandrel fits

perfectly the hole in the saw and no more filing is done than is necessary to bring the teeth to a point, a perfect circle will by this method be obtained.

The saw may be set by laying it on a block of hardwood and striking every alternate tooth with a hammer or punch, and then turning it over and repeating the operation with the remaining teeth. It requires considerable skill, however, to set a saw evenly in this way, and it is preferable, particularly for the novice, to use a carpenter's saw set which may be purchased at any hardware store.

To file a saw properly it should be clamped between two round blocks, about one inch thick and one inch less in diameter than the saw. The blocks may be clamped together on the saw by placing them in a vise. The saw should be filed straight across and should not hook or lean forward of a line drawn from the center of the saw to its periphery.

## CHAPTER XVI.

## FINISHING.

THE duties of the electrotype finisher are to make the face of the electrotype perfectly flat and level, to repair defective letters, or cut them out and replace them with type; to repair defective rules, etc., and finally to bevel the edges of the plates if they are to be worked on patent blocks, or to mount them upon wooden or metal bases.

The tools required to properly straighten an electrotype are a light hammer, with one round face, Fig. 24; a set of punches, Fig. 25; a pair of calipers, Fig. 26, and a rubber, Fig. 27.

The first operation is to beat down the edges of the bearers surrounding the page or engraving with the hammer, after which the plate is laid face down on a smooth, steel-faced finishing block, and planed down with a block of wood and hammer to make it lie flat and solid. If any bad sinks are observed in the electrotype their exact location is marked on the back of the plate by means of the calipers. The plate is then again laid on its face on the finishing block, and with a suitable punch the marked spot is driven down until it is flush with the surrounding matter. After the plate has been rough-finished and straightened it is taken to the rougher, Fig. 28, and a cut taken off the back, which reduces it to an approximately uniform thickness.

As its name implies, the rougher was designed to take the first or rough cut off from the electrotype cast. Its chief utility consists in the fact that a large quantity of metal may be removed at one operation. The electrotype rests face down upon a traveling bed, and

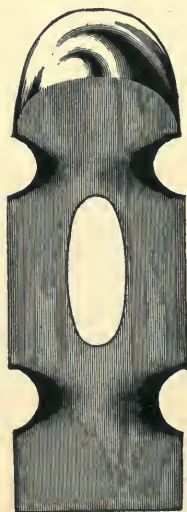


FIG. 24.



FIG. 25.



is held down during the operation of planing by two spring rolls located one on either side of the track of a reciprocating cutter. The cutter is secured in a tool post which is arranged to slide on an arm extending over the bed and at right angles thereto. The cutter is actuated by a pitman, one end of which is connected with a stud on the cutter head and the other with a stud

on the drive pulley. The bed is operated in one direction by a worm, which is driven by a belt from a pulley on the drive shaft, and is reversed by hand.

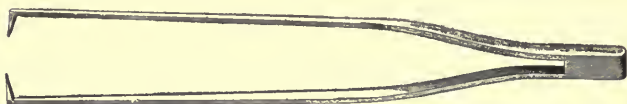


FIG. 26.

While the machine was originally intended for rough work, yet if carefully constructed it can be made to perform its duty so accurately that no further planing or shaving is necessary, and in many foundries it takes the place of the shaving machine.

An improved type of rougher has an adjustable shaving knife located just back of the reciprocating cutter, which frees the plate from the metal chips which

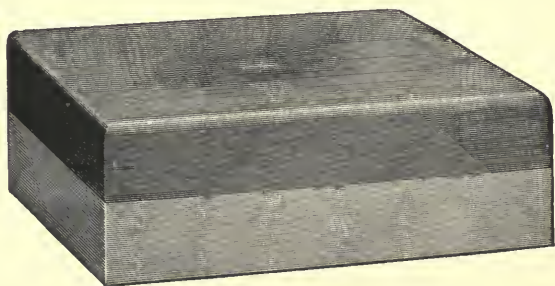


FIG. 27.

become imbedded in the plate by passing under the spring roller, and which would otherwise have to be removed with a file or scraper. The shaver knife also removes the tool marks left by the rougher, and gives the plate a finished appearance.

After the electrotype has been roughed it is taken back to the finishing block and carefully examined. Every minor defect is then remedied and necessary corrections made.

To more readily detect the low spots in the plate, the face of the electrotype is lightly rubbed over with a rubber ink eraser, mounted on a block of wood, or with a piece of fine emery paper stretched over a block. Those portions of the electrotype which do not receive a polish from this treatment are obviously low, and after locating them on the back of the plate with the aid of

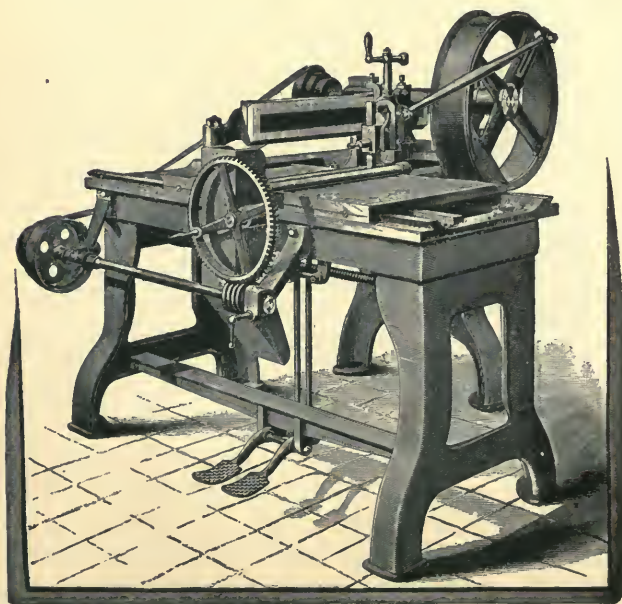


FIG. 28.

the calipers, they are hammered or punched up to a uniform level. After each operation of hammering or punching, the electrotype is planed down and straightened, and again tested with the rubber, and these treatments are repeated until all the dark spots have been brightened.

While the process of straightening an electrotype as thus described is very simple, it really calls for a high degree of mechanical skill, which can be acquired only by long practice.

The electrotype having been straightened and repaired, it is taken to the shaving machine for a final cut, which should reduce its thickness, if a book plate, to exactly 11 points (small pica), this thickness having been adopted by the electrotypers' associations of America as a national standard for bookwork. If the plate is to be mounted on a wooden base it may be shaved somewhat thinner.

Shaving machines are of various patterns and sizes, some operated by steam power and some by hand. The hand shaver consists of an iron table planed perfectly true upon its upper surface, and provided with a stop at one end to hold the plate in position. The side edges of the table are planed true, both top and bottom, and serve as guides for a sliding head to which the knife is bolted. Secured to the rear of the head and traversing the entire length of the machine are steel racks, one on either side, which are engaged by two pinions located on a shaft which is at right angles with the racks. To one end of the shaft a cast-iron spider is keyed, and to the spider long wooden spokes are bolted, which afford the means of operating the head. The head is provided

with brass gibs, and the wear on the gibs may be taken up by means of set screws.

In large establishments shaving machines are usually driven by steam power. There are various devices for applying the power, one of which is illustrated in

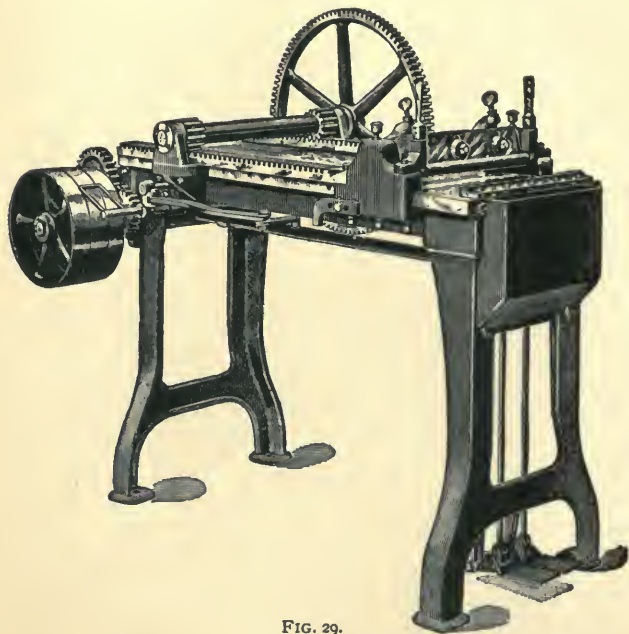


FIG. 29.

Fig. 29. The shaft and pinions acting on the racks are the same as in the hand machine. A large gear wheel is substituted for the spoke wheel on the main shaft and is driven by a pinion to whose shaft power is communicated through intermediate gearing by means of band wheels shown at the left of the machine.

Nearly all shaving machines are provided with a spring roller located in front of and attached by brackets to the head. The purpose of the roller is to press the plate flat down on the bed of the machine just before the knife begins its cut. A plate which is slightly uneven or warped is thus secured against the danger of "gouging," and the necessity for planing or filing a bevel on the end of the plate is also obviated.

Another type of shaving machine has a bed resting on steel wedges which are made adjustable by a screw

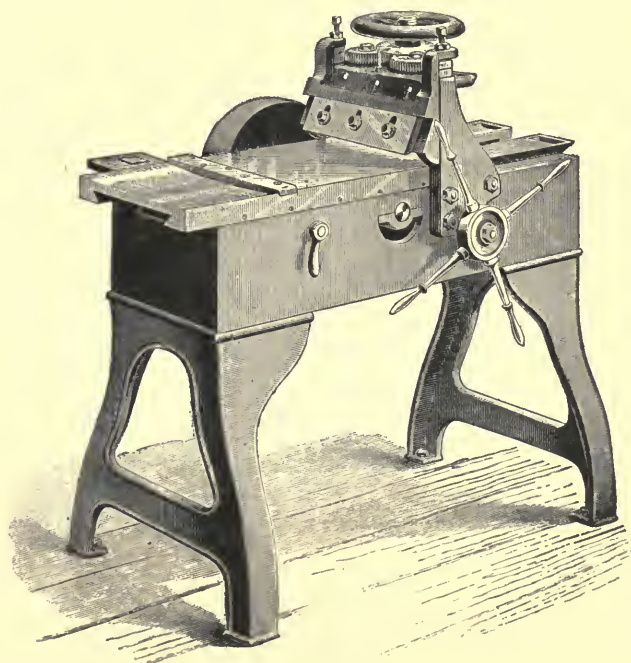


FIG. 30.

passing through the front of the machine and terminating in an indexed hand wheel. By means of this wheel the bed may be raised or lowered to any desired height within the range of the machine.

Fig. 30 illustrates a machine which is of comparatively new design and differs in many respects from other makes. The following description is given by the manufacturer: "The knife remains stationary, the plate to be shaved being placed on a table and passed under the knife. Power is applied to move the table in one direction only, the power being thrown on and off by a lever handle, not shown, convenient to the right hand of the operator. The backward movement is obtained by means of a hand wheel. The table is extended beyond the head toward the front of the machine, affording increased bearing surface and equalizing the wear over all parts of its length; the extended portion, is made slightly concave, on which plates may be bent so that they shall rest properly on the shaving table. At the front of the machine, on the left side, is an inverted plane, by which the plates may be beveled as is usual to prevent the too abrupt commencement of the shaving operation."

## CHAPTER XVII.

## TRIMMING AND ROUTING.

ALL electrotype plates, whether job or book work, require to be trimmed on sides and ends. In the case of wood-mounted plates the trimming is done after they have been mounted on blocks, when plate and block may be finished at one operation. The circular saw is unsuited for such work because of its tendency to spring away from the job, and because its cut is more or less ragged and uneven.

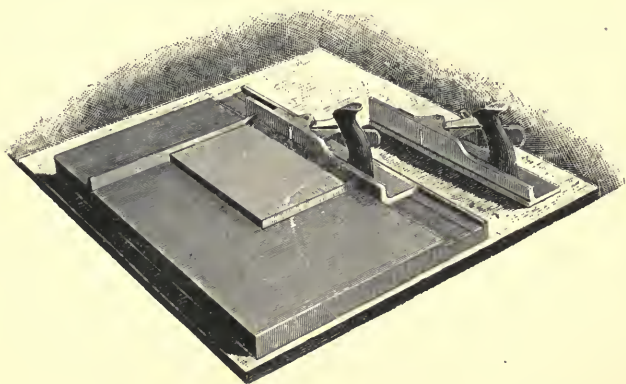


FIG. 31.

Various machines have been designed for the finishing of electrotypes, the simplest and least expensive of which is the shootboard, Fig. 31, which consists of an

iron plate with a gutter or chute along one side in which a plane, furnished with an adjustable cutter blade, freely slides. A stop extending across the bed at right angles with the gutter serves as a rest for the electrotype and also as a guide for squaring the plate. The plane is

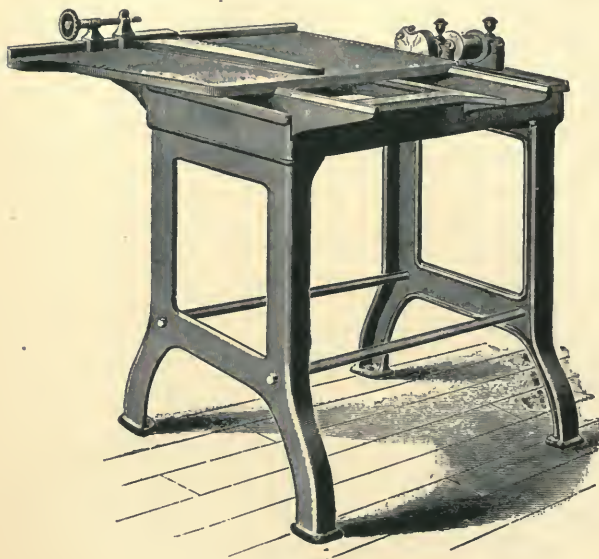


FIG. 32.

provided with two blades, one for making a square edge and one for producing a beveled edge such as is required on book plates.

Fig. 32 illustrates a very convenient and efficient trimming machine, specially designed for finishing type-high or "body" work. A rapidly rotating arbor carrying a cutter head, in which are secured two or more

cutting tools, is journaled in a substantial iron frame. The work is carried past the cutters on a reciprocating carriage which slides on ways parallel with the cutter head. The carriage is furnished with a right-angled adjustable gauge against which the work rests, which is adjusted by a finely threaded feed-screw, admitting of close and accurate work. The trimmer head should travel at a speed of about 3,500 revolutions per minute.

To prevent the work from being drawn into the cutters and mangled it must be held securely on the carriage. Large and heavy pieces may be held by the fingers without danger, but the very small pieces, such as one, two or three line electrotypes, should be held by a lineholder, Fig. 33. The lineholder is an oblong



FIG. 33.

block of iron ten or twelve inches in length, two inches in width, and one inch high. A dove-tailed groove, extending the full length of the side face of the block, admits two thin serrated clamps, one of which is secured by means of a set screw at any desired distance from the end of the block, and the other is pivoted to the end of a lever which is operated by a handle on the top of the block. The under side of the block is recessed to receive a spiral spring which is attached to

the lever and serves to hold the clamps firmly together upon the work. In operation the block is placed upon the carriage of the trimmer, the clamp jaws separated by means of the handle and the work inserted between them. On releasing the handle, the spring acting on the lever draws the clamps together. The work is thus securely held and may be trimmed without danger to the eyes or fingers of the operator, provided the lineholder itself be held firmly against the side gauge of the machine during the operation of trimming. It should be impressed upon the workman that whether trimming large or small pieces it is important that the carriage be kept free from chips. More accidents have been caused by carelessness in this regard than from all other causes combined. A chip or a small piece of metal under the work will cause it to chatter or rock when it encounters the cutters, with the result that the workman often loses control of it; and even if he is not injured by flying fragments his work will be destroyed.

Two kinds of cutters are used in trimming machines, one for trimming metal and the other for wood, or wood and metal combined, such as job or book plates mounted on cherry or mahogany blocks. The cutters should be made of Stubs' tool steel, hardened, and the temper drawn to a purple color. The holes in the cutter head are usually made round, in which case round steel of a size which will accurately fit the holes should be used for tools. The cutting ends of the metal cutters must be squared for at least a half inch back from the end—that is to say, there must be one right-angled corner to do the cutting. Fig. 34 is a side and end view of a

metal cutter, and Fig. 35 illustrates a wood cutter or "goose-bill."

It sometimes becomes necessary to deepen the relief in an electrotpe to prevent blacking or smutting the paper in printing. While this operation may be per-



FIG. 34.

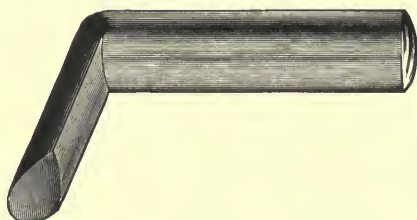


FIG. 35.

formed with a mallet and chisel, it is always preferable to employ a router, Fig. 36. In this machine a rapidly revolving vertical spindle carries on its lower end a chuck in which may be secured cutting tools of various sizes suited to the nature of the work to be performed. The box in which the spindle turns is bolted to a handle-bar, one end of which serves as a handle for guiding the tool over the work, while the other end is pivoted to another handle-bar which is again pivoted to the frame of the machine. The double joints thus formed permit the tool to be moved freely in any direction over the bed of the machine. The second handle-bar is supported at the elbow formed by pivoting together the two bars, by a steel segment, and the first handle-bar

rests on a straightedge of hard wood extending the entire length of the machine. The ends of the hardwood slide are supported by spring studs, which hold

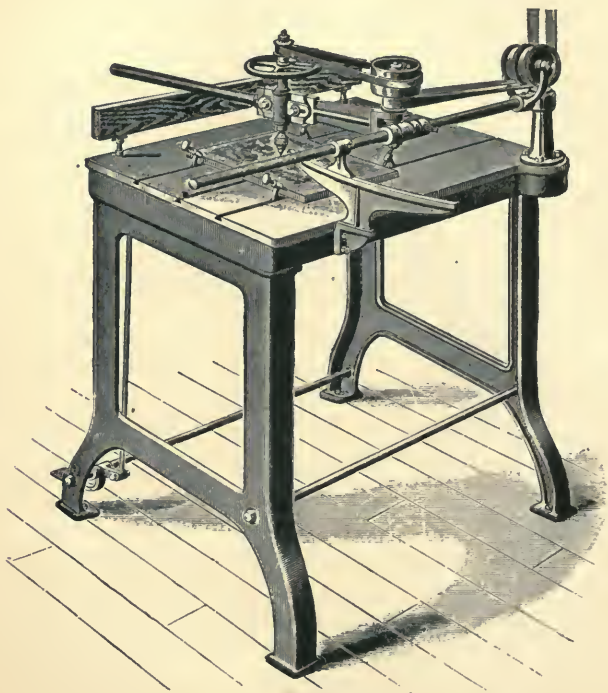


FIG. 36.

the handle-bar carrying the spindle high enough from the table so that the cutting tool clears the work when not in operation. A pedal attached to a lever underneath the machine affords a means of compressing the springs, thereby permitting the tool to enter the work.

The tool spindle is adjustable in a vertical direction to provide for plates of different thicknesses, as when a change from type-high to plate work, or vice versa, is desired. This adjustment is obtained by means of a hand wheel attached to a threaded sleeve in which the spindle turns. The sleeve is provided with a feather to prevent its turning, so that a movement of the hand wheel in either direction raises or lowers the spindle. The work is held in screw clamps, which slide freely in dovetailed grooves planed in the bed of the machine. Power is transmitted to the tool spindle by a belt passing over idle pulleys at the corner of the machine. The pulleys at the pivotal points of the radial arms enable the operator to move the spindle freely in any direction without changing the tension of the belt. To perform smooth and rapid work router tools require to be driven at a high speed. For electrotpe metal the speed should be about 12,000 revolutions per minute. A machine running so rapidly should, of course, receive careful attention. The bearings should be kept clean



FIG. 37.

and well oiled, and must not be permitted to become overheated. Router tools for general work are about the size of a lead pencil. For special work they may be made as small as one-sixteenth of an inch in diameter, and when large quantities of metal are to be removed, the size of the tool may be increased to one-half inch. The cutting end of the tool is made in

the shape of a half moon, as shown in Fig. 37, the leading point being slightly longer than the heel, to prevent clogging. This tool is sharpened by grinding the end only, and may, therefore, be easily kept in order.

Book plates, when finished ready for the press, are usually mounted on patent blocks, and are secured to



FIG. 38.

their bases by bevel clamps which lap over the edges of the plates. It is, therefore, necessary to provide a beveled edge for the plates. This work may be performed on a shootboard by using a suitable plane; but when a large number of plates are to be prepared, it is customary to employ a beveling machine—Fig. 38. This machine resembles a trimmer, but has an adjustable vertical shaft. It has a reciprocating carriage to carry the work past the cutters, is provided with gauges for the alignment of the work, and may be adjusted so as to produce either a rabbet or bevel, as may be desired.

## CHAPTER XVIII.

## REVISING.

AFTER book plates have been straightened, shaved and beveled, a proof is taken, and it sometimes happens that errors or omissions are then discovered which make changes and corrections necessary. Such changes may consist in some cases of only a single letter, while in others an entire line or paragraph may be involved. In the former case, the defective letters are punched out and type inserted in their places, and in the latter, the line or paragraph is set up and electrotyped, and after cutting out the defective portion of the plate the new piece is set in and soldered. The special tools required for this work consist of a set of punches and chisels and a pair of calipers, such as have been previously described; a revising stick (Fig. 39), a blow pipe, a pair of cutting pliers, a soldering iron, some small flat files, and a light hammer. A complete set of chisels and punches consists of eight sizes, and corresponds with the different sizes of type in general use, namely: pica, small pica, long primer, bourgeois, brevier, minion, nonpareil and agate. The thickness of the tools corresponds with that of the letter i in the respective fonts.

The revising stick may be made of a piece of printers' brass rule, six or more inches in length. To one edge and one end of the rule a strip of brass one-eighth

of an inch square should be soldered, as shown in Fig. 39. This makes a convenient, and in fact indispensable tool for holding a line of type while fitting it to the slot in the plate in which it is to be soldered.

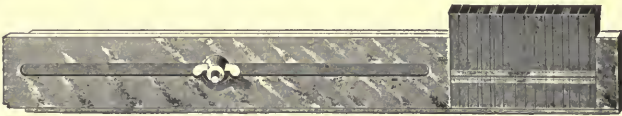


FIG. 39.

A line gauge, Fig. 40, is employed for detecting errors of alignment between the inserted type and the remainder of the line, and is also employed for the alignment of newspaper headings or other jobs composed of capitals and lower-case letters. In trimming a line composed of a capital letter followed by several lower-case letters, the width of the block, of course,

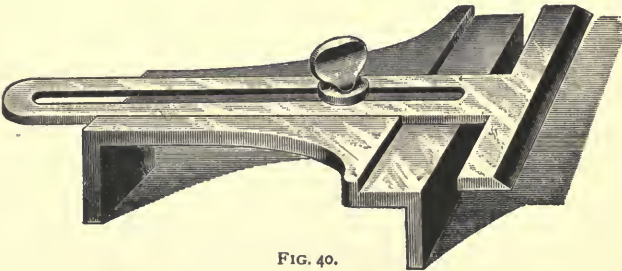


FIG. 40.

must correspond with the width of the capital, and it is obvious that without a guide it would be difficult to trim the block so that the lower-case letters would all be at an equal distance from the top and bottom of the block. The same difficulty would occur in trimming

any kind of a job requiring a margin above and below the matter. The line gauge enables the operator to trim the edges of such jobs exactly parallel with the printing face, and is, therefore, an important and almost indispensable tool. When used in revising, the edge of the gauge is set in alignment with the line in which a correction is to be made. After the type has been inserted, and before it has been permanently secured by soldering, an application of the gauge will determine whether the alignment is perfect.

The blowpipe is used for soldering in places which cannot be conveniently reached with a soldering iron. It consists of a Y of brass tubing, one of whose arms is connected by a rubber tube with the gas supply. By blowing in the other arm of the Y a stream of air is mixed with the gas. The point of flame may be directed and focused on any desired point, however small.

Referring to Fig. 41, it will be observed that the cutting ends of the revising punches are provided with V grooves, which give to the tools two cutting edges,



FIG. 41.

thus admitting of a sharp, clean cut through the plate of just the size of the type which is to be inserted. In correcting a typographical error in a plate, the workman first marks with his caliper the exact location of the

letter upon the back of the plate. With a small chisel a groove is then planed at the point marked by the caliper to the depth of about one-half the thickness of the plate. A punch of the proper size having been selected, the plate is turned over, face up, upon a block of wood, and with a sharp blow with the hammer the letter is punched out. Turning the plate over again, face down upon the finishing block, the type is inserted in the hole, and the contiguous metal crowded against it with a chisel until it is secured against dropping out, when the face is examined to see that the inserted type is in alignment with the remainder of the line and level with the surface of the plate. Care must also be observed to keep the type on its feet — that is to say, it must not lean from the perpendicular. The body of the type which has been left projecting through the hole is now cut off with the pliers level with the back of the plate, and the type secured in its position with a drop of solder. It is of course necessary to observe some care, otherwise there would be danger of melting the surrounding metal or the type itself. After the type is secured the superfluous solder is removed with a chisel or file.

When several consecutive letters are to be inserted in the plate, the hole made with the punch is enlarged with chisel and file to the size of the correction, and the type which has been previously set up in the revising stick is inserted and temporarily secured as before. Somewhat more skill is required to make a correction of this kind than to insert a single letter, as the slot must be kept parallel and in exact alignment with the remainder of the line, and this is a more difficult matter

than to punch a single hole in the plate. When the slot has been made too large, as sometimes occurs, the type is aligned by crowding the contiguous metal against that side of the type which is above or below the line. When the type has been properly placed it is usually partially secured by soldering before cutting off the body; otherwise there would be danger of disturbing it.

When the correction consists of several words or parts of lines, the matter is set up and electrotyped in the usual manner. The corrected piece so made is laid on the plate in the position it is to occupy, and with a graver or other sharp-pointed tool its exact outline is transferred to the plate. A hole is drilled in one corner and the defective portion of the plate cut out with a jig saw — Fig. 42. The correction is then inserted, the plate turned face down and a drop of solder applied to each of the four corners. During the operation of soldering, the plate and correction should be firmly held against the finishing block to prevent warping or springing of the pieces, which might otherwise be caused by the heat of the iron. For this purpose the cutting pliers may be reversed, the end of one handle being used to hold the plate and the other the correction.

A necessary part of the equipment of an electrotype foundry is a set of brass standards based upon the printer's universal unit of measurement, the pica. These standards should be twenty-six in number, ranging from one to twenty-six picas in length. The convenience of such standards will be apparent when it is remembered that all large type, such as is employed for newspaper headings, etc., is made to occupy the space of a certain

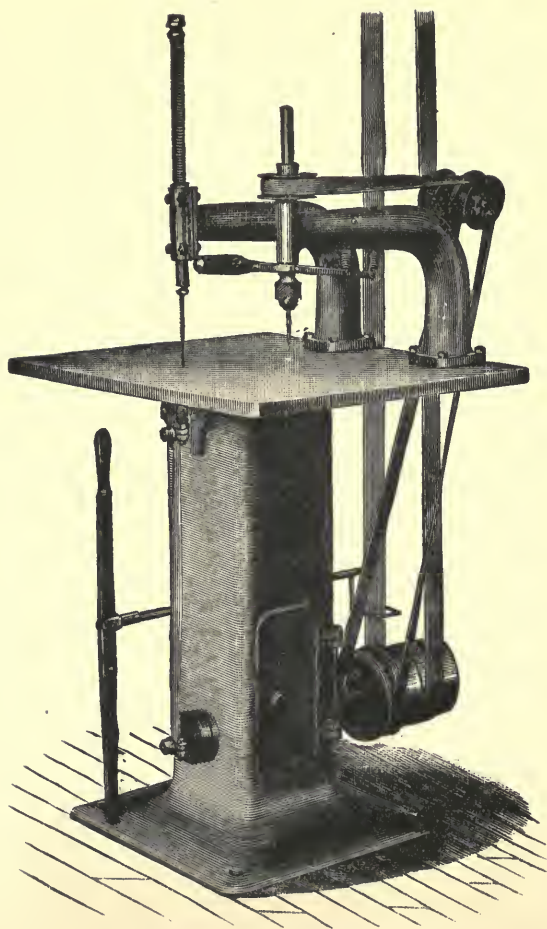


FIG. 42.

number of lines of pica and is called 6-line type, 7-line type, etc.

In addition to the pica standards, the electrotyper should have a type-high standard, preferably made of steel, about 2 by 3 inches in size and .919 of an inch thick. Such a standard is useful not only for testing finished work, but also for setting the knife of the shaving machine, for which purpose it is placed on the bed of the shaver and the knife screwed down until it will just touch it.

Book plates are usually worked on patent blocks and should be shaved to exactly eleven points (small pica) in thickness. For testing this class of work a standard should also be provided.

## CHAPTER XIX.

## BLOCKING.

BOOK plates are usually worked on patent blocks, with which every large publishing house is supplied. These blocks are made in some cases of wood, but preferably of iron, accurately finished and provided with clamping devices for securing the plate to the base. The best blocks are made in sections, and may be arranged and adjusted to fit various sizes of plates. The clamps are beveled and made adjustable so that they will fit snugly over the beveled edge of the plates.

Plates which cannot be worked on patent blocks are secured by screws, tacks or anchors to wooden blocks. Mahogany makes the best blocking wood, but is rather expensive for general work. Cherry comes next, and is the wood most generally employed for blocks; birch and maple are also used to some extent. Blocking wood may be procured ready for use, kiln dried, and surfaced to proper thickness; but most electrotypers prefer to purchase lumber in the rough and dress it to thickness as it is required for blocking, thus avoiding danger of warping, which is likely to occur when the wood is dressed several days in advance of its use.

Lumber which has been thoroughly dried in the yard is superior to kiln dried lumber because it is less susceptible to changes of atmosphere. When sufficient space is available it is always advisable to carry a stock

in the foundry, where it soon becomes seasoned. It often happens, however, that well-seasoned lumber cannot be procured and kiln drying then becomes necessary. By whatever process the wood is dried it should



FIG. 43.

be thoroughly done, otherwise the block will warp after the electrotype has been secured to it, probably after it has been delivered to the printer, in which case much annoyance and expense will inevitably result.

Blocking wood must be surfaced on both sides and with perfect accuracy to insure good printing. For this purpose a rotary planer, Fig. 43, is almost indispensable. The peculiar advantage of this machine consists in the fact that it dresses the wood perfectly flat and level, no matter how badly it may have been warped or sprung before planing. In this respect it is far superior to the ordinary wood planer, for, while the wood is flattened by the pressure rollers during the operation of planing, it springs back to its original shape on being released.

Referring to Fig. 43, it will be observed that the cutting tools of the rotary planer are secured in a revolving disk which is made vertically adjustable by means of the crank shown at the top of the machine. Power is communicated to the disk by a belt passing over idlers at the rear of the upright frame to the pulley on the disk shaft. One of these idlers is secured to a shaft which carries on its outer end a grooved pulley which provides a means of transmitting power to the worm shaft shown at the side of the machine. The worm wheel driven by this shaft is secured to a shaft passing under the traveling bed, and is provided on its inner end with a small pinion which engages the rack attached to the under side of the bed. By a simple mechanism which is at all times in control of the operator, the worm is thrown out of gear at the termination of the cut and the bed returned to its first position by hand. The lumber is held during the operation of planing between the jaws of two clamps, one of which is stationary and the other connected with a screw which terminates in the crank handle shown at the front of the machine. In opera-

tion, the board is placed between the jaws of the clamps and locked by means of the crank mentioned. The board is thus secured against springing or rocking while its upper surface is dressed perfectly true and level. The board is then turned over with its flat surface against the bed of the machine, and again passed under the cutters, which reduce it to the required thickness. The disk is raised and lowered by a graduated adjusting screw operated by the crank shown at the top of the machine, and may, therefore, always be returned to the proper height for the finishing cut without going to the trouble of comparing each board with a standard. Owing to the large size of the disk and the fact that the tools are located near its periphery, the machine should be driven at a speed not exceeding 1,500 revolutions per minute.

After planing, the boards are cut into convenient lengths for handling, and the plates secured to them by means of wire brads or screws, or both. Brads may be driven through the thin places (spaces) in the plates, but for the screws holes should be drilled and countersunk in order that the heads may be sufficiently depressed to avoid danger of blacking or smutting in printing. Where a plate has no spaces or blanks where brads or screws may be driven, it is customary to "anchor" the plate to the block. For this purpose holes about one-fourth of an inch in diameter are bored through the block and deeply countersunk on both sides. If the plate has been finished long enough to have become oxidized, the back should be brightened by filing, and is then laid on the block and temporarily secured thereto by hand clamps. It is then turned over

on its face, and, after a very small quantity of soldering fluid has been applied to the plate through the holes, melted solder is poured in until the holes are full. It is important, of course, not to get the solder too hot, as in that case there would be danger of its melting through the plate. There is always an element of uncertainty in securing electrotypes to blocks by this method, and, when possible, it is best as an additional safeguard to rabbet the edges of the plate and drive in a few brads. When the plate is small, it may sometimes be fastened securely in this way without the use of anchors.

When several small cuts are to be blocked at one time, it is customary to tack them on to a board as large as may be conveniently planed, leaving sufficient room between the cuts to saw them apart. Should it be necessary to take a final shaving off the bottom of the cuts after they have been blocked, it may be done more economically if several are shaved at a time than if each one were to be handled separately.

Very large blocks are liable to warp in time, in spite of any precautions which may be taken to prevent it, and to reduce this tendency to a minimum each block should be strengthened by end strips crossing the grain of the block. The strips may be secured to the blocks by countersunk screws, but a more satisfactory method is to dovetail them together. A machine specially designed for this work is illustrated in Fig. 44. The cutting tools are a thick gouge saw of about No. 3 gauge, which cuts a slot in the board or strip, and a vertical revolving cutter, which follows in the slot and changes it into a dovetail groove. The mechanism for

driving the tools is sufficiently explained by the engraving. The parallel side gauge, against which the board is pressed during the cutting of the dovetail, can be instantly changed by means of the small lever at the

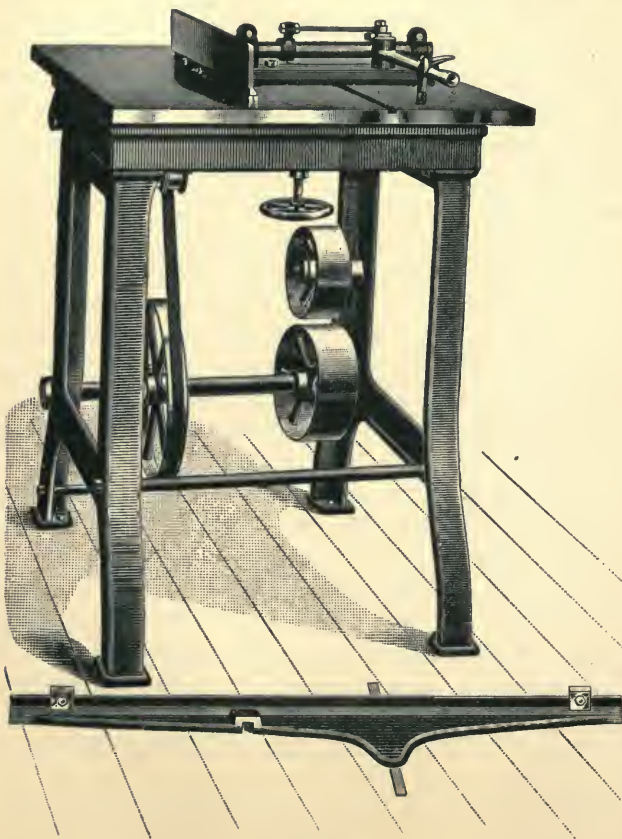


FIG. 44.

right of the machine so that either the center or the edge of the strip may be thrown in alignment with the cutters, thus providing a means of cutting a dovetail in one board and a tenon on the other. The mechanism for changing the side gauge from one position to the other is such that there can be no variation in the distance it is moved, and whatever position it occupies it is automatically locked therein, thus insuring absolute uniformity of work. The machine may be readily adjusted to operate on lumber of different thicknesses.

## CHAPTER XX.

## DR. ALBERT'S METAL MOLDS.

THE subject of metal molds is one in which all progressive electrotypers are interested, and we have therefore translated from the German Dr. Albert's description of his process, which is sufficiently in detail to enable the skilled electrotyper to comprehend how it is possible to mold in lead. Dr. Albert does not explain the nature of the mechanism by which he is able to obtain "successive partial pressures" on "any press," nor does he describe fully the character of the alloy which he employs in loosening the shell from the matrix. The American patents concerning Dr. Albert's process have been purchased by an American manufacturer of electrotyping machinery, who has already installed several plants in this country which are in more or less successful operation. The following is a translation from "Theory and Practice of the Metal Matrix," by Dr. E. Albert:

"Jacobi, the inventor of the art of electrotyping, has for more than half a century experimented in producing lead matrices for engraved steel and copper plates, and with the greatest success. Nevertheless, the wax and gutta-percha matrix has been the popular method of electrotyping until recently, although the defects of the electrotypes made from it urgently called for a change in the method.

“ The origin of these defects is to be found principally in the fact that the non-conducting material must first be made conductive by brushing with black lead, whereby it is impossible to avoid an essential deterioration in quality as compared with the original; and that in consequence of the necessary heating of the material before the impression is taken, and the changes in its dimensions after cooling, an exact register of electrotypes for multi-colored prints can not be guaranteed. With the possibility of using conducting and cold-molded metal matrices, all this inferiority of the electrotypes, as compared with the original, is at once removed.

“ But modern printing forms, such as photoengravings, woodcuts, type forms, heliogravure, can not be impressed in soft metal in the same manner as in wax and gutta-percha. The requisite pressure would be so great that the soft printing material would be destroyed.

“ Some attempts to avoid the high pressure in producing metal matrices by using very thin lead foils and putting on them layers of thoroughly saturated pasteboard, or wax, have never had any practical results, although they date back to the forties in the last century, and for the following reasons:

“ Every electrotyper knows that in molding from mixed type and cut forms the type is impressed long before the shading of the woodcut or a photoengraving is molded. The above-mentioned thoroughly saturated pasteboard affects the impression just as wax or gutta-percha made soft by heating, i. e., the lead foil must first be pressed into the large and then into the

smallest depressions of the printing form by the saturated pasteboard. In spite of the enormous ductility of lead, it will not, of course, satisfy this demand for expansion.

“It must be considered that in the square millimeter of a photoengraving there are thirty-six depressions into which the lead foil must be pressed, and that it applies itself to 144 side walls per qmm. In underetched printing-plates considerable force is necessary to separate the matrix from the plate, and, therefore, it is impossible in larger forms, without distorting the mold, to separate the plate from the lead foil, which, in the interest of lessening the pressure, must be very thin.

“The pressure necessary for forcing any molding material into the smallest depressions of a form can not be produced as long as an opportunity remains for it to make its way into open spaces. In consequence of this characteristic, all wax matrices must be subjected to a shaving process to remove the large angular protuberances, which correspond to the depressions in the printing form. This necessary manipulation would, of course, be impossible in matrices consisting of thin lead foil, and also for these reasons the use of this method for rule etching, woodcuts and type matter is excluded.

“It has been pointed out as a characteristic of the materials hitherto used for the production of matrices that the molding of the largest depressions is done before that of the smallest. With soft metals, especially lead, the contrary is the case, as this material first shifts in the direction of the pressure and fills the

small depressions. With increased pressure, which is necessary in order also to press the lead down in the large depressions of the form, the lead also begins to shift like wax to the sides in the neighborhood of the first-molded parts.

“Apart from the fact that the already molded little points, which correspond to the smallest depressions in the form, will be shaved off, this shifting of the lead has another disadvantage, namely, that the lead lodges in these smallest depressions and the original will be made unfit for use through this filling up with lead. Besides, neither type matter nor cuts will withstand the enormous pressure that must be used to impress a lead plate of at least five millimeters (about one-fifth of an inch) thickness into the large depressions.

“But such a thickness in the lead plate would be just as necessary as in the wax or gutta-percha, as the difference in height between the face of the type and that of the spacing is about one pica.

“With the present means, therefore, matrices can not be produced in metal plates, and it has been necessary to use wax or gutta-percha for this purpose, until, in the year 1903, Dr. Albert succeeded in establishing a method for the rational production of metal matrices. This method is based on a number of inventions and is patented in all civilized countries.

“The knowledge that depressions in the electrotypes in the blank spaces are required only to prevent smearing in the subsequent printing of the electrotypes, led to the course of pressing or bending a lead plate of about two millimeters (about seventy-eight one-thousandths of an inch) thickness into said depres-

sions only so far as the technical necessities of printing demanded, by means of a backlayer of some soft material.

"This method is accordingly based upon a combination of impression and bending. The bending of the lead will be greater the larger and wider the depressed surface is, and the blank places will therefore be of such a depth that they will not smear in printing. The process is illustrated by Figs. 1 and 2.

"Fig. 1 shows the arrangement of the press platen, the lead plate and the soft, elastic intermediate layer

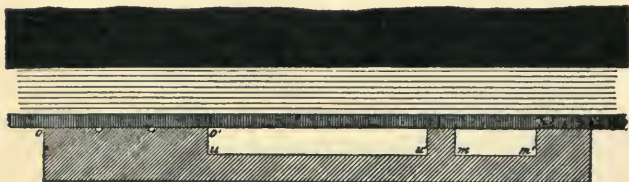


FIG. 1.

before the impression is taken. The material used for this purpose must originally, or in its arrangement, be of certain qualities, and must be softer than the molding material. It must be compressible without giving way sideward under the pressure; but it must also give a certain resistance to the compression in order to be able by this power of resistance to bend the lead plate where it lies over the hollow. This material, however, should not be so soft as, for example, heated wax, but should be porously soft, either in its nature or in its arrangement. A certain degree of elasticity is useful in the interest of the bending of the molding plate into the depressions in the form.

“ Such intermediate layer can suitably consist of a number of layers of paper, and such a one is, through the nature of the fiber of the paper, as well as through the air inclosed between, soft and elastic in itself in respect to the vertical direction toward the surface of impression; while, on the other hand, through the texture of the paper, the necessary check will be given to prevent the paper from gliding sideways at the beginning of the pressure. In earlier experiments the latter tendency was prevented by saturating the paper.

“ In Fig. 2 the platen is lowered so that the intermediate layer between the points  $o$   $o'$ , from which the first counterpressure comes, is compressed to half its original volume. In the moment when, through com-

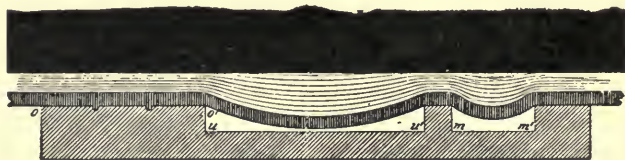


FIG. 2.

pression, the intermediate layer has reached the same degree of hardness as the molding material, the next increase in pressure will press this material into the smallest depressions of the surface  $o$   $o'$ . The lead lying perfectly free between the points  $u$   $u'$ , and therefore exerting no counterpressure, will simultaneously be pressed down in the hollow space  $u$   $u'$  as an effect of the resisting power of the intermediate layer.

“ The same will be the case between the points  $m$   $m'$ , although in a lesser degree, just as a board that

is supported at intervals of two meters will sag more than one whose supports are only one meter apart, with the same weight on it.

“ By the use of this bending process, the requisite molding pressure is reduced to one-tenth of what would otherwise be necessary, and the use of metal molds is made possible.

“ The question of producing the metal matrix was thus solved only for moderate sizes, for, even if the pressure was considerably lessened by the correct selection of the thickness of the lead plate and by the back-layer of a soft, elastic matter, still an essentially greater pressure than is required for wax or gutta-percha is necessary. The usual hydraulic presses with about one hundred atmospheres were consequently not usable for the impression of larger sizes.

“ By using a successive partial pressure and at the same time introducing a secondary pressure, Dr. Albert has succeeded in changing any press to a twenty times higher capacity at very small cost. This gradual progress of a limited pressure over the whole form affords an opportunity for the air to escape and prevents troubles arising from this cause. As the shifting proceeds automatically, there is no loss of time worth mentioning in this method. For example: The molding of a form of *Woche* (the *Week*) requires only a period of fifty-five seconds, and for a form of *Berliner Illustrirte Zeitung* (*Berlin Illustrated Gazette*) not quite two minutes. For molding of cut forms of the same size only half of the time mentioned is required. With this method there is no difficulty whatever in producing molds of any size.

“It is self-evident that a copper shell deposited on a lead matrix can not be loosened directly, as is the case with a wax matrix. It would not be possible to melt the lead away from the copper without injury to the electrotpe. But by letting the matrix and copper deposit float on a very easily fusible metal alloy with many free calorics, this loosening succeeds so well that the same matrix can be used five times for the production of new electrotypes without affecting the quality of the electrotypes. Thus the problem of the metal matrix is perfectly solved in all respects.

“These inventions have made a revolution in electrotyping technics. The word *revolution*, however, has more reference to the clearness, rapidity, cheapness and quality of the production than to the change of the working methods and arrangements of already established electrotpe foundries.

“Of great importance is the discarding or doing away with the blackleading of the mold matrix, whereby in soft printing elements of photoengravings, etc., a shifting of the tone values in respect to the original occurs. The metal matrix in itself conducts the electricity and needs no blackleading.

“The Albert electrotpe is identical with the original. A difference in the print of both can not be detected. This identity of the Albert electrotpe and the original, in respect to the tone values, is based on the nature of the metal matrix and is not dependent on the skill of the workman.

“The molding process itself can be done on any hydraulic press in use. The machinery for successive partial pressure can be set up in a few hours at a small

expense. The increase of the capacity of the press is enormous; with 120 atmospheres (1,800 pounds to the square inch), with 40 centimeters piston diameter (about 16 inches) photoengravings, 40 by 50 centimeters (16 by 20 inches) large, can be molded. Faulty moldings, as in wax, which are occasioned by inclosed air, do not generally occur, as the air always has a chance to escape during the successive partial pressure.

“It has already been mentioned how little time is necessary for successive partial pressure when suitable arrangements are made. Wax and gutta-percha have not only to be blackleaded after molding, but by heating be brought to a certain degree of softness before molding. In this way changes in the dimensions arise when the molds cool off, and exact register can therefore not be guaranteed in electrotypes for multi-colored prints. The metal matrix is perfectly cold-molded, and therefore an exact register in multi-colored prints is always assured.

“Thus the metal matrix is cleaner and more rapid than wax or gutta-percha, and, besides, is of a quality that guarantees the identity of the electrotypes with the original. The financial advantages of the Albert electrotype will be seen in the further manipulation of the matrix.

“After the lifting off of the form, the matrix will, without any afterwork whatever, be fastened with four nails to a board, whose suspending bow touches the matrix by contact, and the latter will at once be coated over the whole surface with copper in the same moment it is suspended in the bath. Owing to the high melting-point of the matrix, the copper bath can,

without any danger to the matrix, be heated to 50° to 60° Celsius (which will allow an increase in the current tension of eight to twelve volts), and the formation of a sufficiently thick copper deposit will follow in a hitherto-considered impossible short time; for medium sizes only one-half to one hour for producing the deposit is needed.

“ Besides this shortening of the time for producing the deposit, the high temperature will act favorably on the physical character of the electrically deposited copper, as well in respect to its hardness as to its elasticity, which also is evident in the fact that the electrotypes need only a minimum straightening.

“ The loosening of the copper shell from the metal matrix is done so easily, rapidly and surely that no damage to or change in the metal matrix or copper shell results. The matrix can therefore at once be suspended in the bath again for a second copper deposit, and this second electrotype, as well as the third and fourth, is in no way inferior to the first electrotype.

“ When the matrix is not to be used any more, it can be converted into backing metal. The loosened copper shell can, of course, be backed in any way desirable, and the electrotype be made ready for print in the usual way. Only one hour and a half is needed (inclusive of the molding and copper deposit) for putting the electrotype in shape for the press.”



## REFERENCE LIST

### OF TERMS, PROCESSES AND APPARATUS.

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ACID, TO ASCERTAIN PERCENTAGE OF, IN SOLUTION.—Dilute 10 grams of the solution with an equal quantity of distilled water. Add normal soda solution until Congo paper is no longer colored blue. The number of grams of soda solution consumed multiplied by 4.9 gives the number of grams of acid per liter. One liter equals 1,000 grams.

ACID, EFFECT OF, ON NICKEL BATH.—The presence of a small quantity of free acid in the nickel bath effects the reduction of a whiter nickel than in the case with a neutral or alkaline solution. Hence a slightly acid reaction of the bath due to the presence of citric acid, with the exclusion of the strong acids of the metalloids, can be highly recommended. The quantity of free acid must, however, not be too large, as this would cause the deposit to pull off.

ACID, EFFECT OF, IN SOLUTION.—According to Von Hubl, the minimum current density per square foot of cathode in a fifteen per cent blue vitriol solution without acidulation is 24.1 amperes, while the same solution with six per cent sulphuric acid added required but 13.9 amperes.

ACID, HYDROCHLORIC.—The pure acid is a colorless fluid which emits abundant fumes in contact with the air and has a pungent odor by which it is readily distinguished from other acids. The specific gravity of the strongest hydrochloric acid is 1.2; the crude acid of commerce has a yellowish color, due to iron, and contains arsenic.

ACID, MURIATIC.—See hydrochloric acid.

ACID, SULPHURIC.—Ordinary sulphuric acid has a specific gravity of 1.84. It is used in the preparation of the

depositing solution. In diluting the acid with water, it should in all cases be added to the water in a gentle stream and with constant stirring, as otherwise a dangerous explosion might result. While it is known that sulphuric acid aids in making the bath conductive, there is, of course, a limit to the quantity which may be advantageously employed, and it is doubtful if this point has ever been exactly determined. The writer has been to some trouble to ascertain the views of certain practical electrotypers on the subject and compared them with the recommendations of numerous scientific writers. From these various sources of information we learn that the solution of copper should show a specific gravity of from  $14^{\circ}$  to  $18^{\circ}$  B., and that to the solution should be added sulphuric acid in sufficient quantity to increase the density of the mixture from  $\frac{1}{2}^{\circ}$  to  $9^{\circ}$ . This wide divergence of opinion is probably due in some cases to the effort of the electrotyper to adapt his solution to the current strength which his dynamo may happen to be generating.

**ACID, SOLDERING.**—Prepared by dissolving scrap zinc in hydrochloric acid (muriatic acid) to saturation, and adding from 25 to 50 per cent of water. The operation should be conducted in the open air, as the fumes produced are both disagreeable and dangerous.

**AGITATION, BENEFITS OF.**—The continuous agitation of the copper bath is of great advantage to the electrotype, particularly when rapid deposition is desired. The copper is more evenly deposited and of better quality, the formation of gas bubbles, nodules and excrescences is largely prevented, while the annoying streaks which sometimes appear on the deposit, usually as a result of an excess of metal in the solution, are seldom or never seen in an agitated bath. But the principal advantage may be found in the fact that much higher current densities may be utilized, resulting in a corresponding increased rate of deposition.

**AGITATION, DOES IT ELIMINATE RESISTANCE?**  
—While agitation is a practical and useful aid to deposition of metals, and is recognized as such by all electrotypers who have

given it a trial, as well as by all the great copper refiners of Europe and America, its chief value consists in the fact that it promotes uniformity in the composition of the solution, aids in the diffusion of metal in the solution, and, when a strong current is employed, prevents to a certain extent the formation of nodules, excrescences and streaks on the cathode. It also minimizes the tendency to polarization and promotes purity in the character of the copper deposited. If inequality in the composition of the solution tends to increase the resistance of the solution, then agitation, by promoting uniformity, would diminish the resistance to just that extent. It is doubtful, however, whether the mere fact of giving motion to a solution adds to its conductivity. In other words, if an agitator should be introduced into a depositing solution which had previously been employed for electrotyping without agitation, and if no change were made in the content of acid or metal in the solution or in the speed of the dynamo, the increase in the rate of deposition would probably be inappreciable. It should be understood that some motion always takes place in the solution whenever deposition is going on. Without motion there could be no diffusion, and without diffusion there could be no deposition, for it is obvious that there must be constant renewal of metal in the solution next the cathode, as otherwise it would soon become exhausted. This motion is caused by the sinking of the heavy liquid next the anode and the constant rising of the liquid next the cathode, where it is deprived of its metal, and consequently becomes lighter than the surrounding liquid. This motion, together with the stirring of the solution occasioned by the immersion and removal of the cathodes, is sufficient for the diffusion of the metal when a current of low density is employed. It is true that a solution undisturbed for some time will become more acid at the top than at the bottom and, therefore, more conductive at the top than at the bottom. Yet it is doubtful if the total resistance of the solution is very much affected by this condition. Granting that agitation would diminish the resistance of the solution to a slight extent by promoting uni-

formity, it is certain that it does not influence the resistance beyond this point, for frequent tests have demonstrated that the current strength measured at the electrodes remains unchanged whether the agitator be in operation or not. But if the agitator does not in itself increase the rate of deposition, it enables the operator to increase his current and thereby accomplish practically the same purpose. Von Hubl found by careful laboratory tests that the current strength could be increased about fifty per cent when the bath is kept in gentle motion. This statement is very conservative and probably means that the current strength may be increased fifty per cent without changing the character of the copper or causing waste of power by polarization. If no consideration be given to economical working, there is no doubt but the current may be increased far beyond the fifty-seven amperes per square foot which he gives as a maximum.

**AGITATION, METHODS OF.**—One of the main objects of agitation is to remove the exhausted stratum of solution next to the cathode and replace it with a saturated solution in order that deposition may proceed with the greatest possible rapidity. Various mechanical means are employed to effect this object. The most popular method is that of forcing air through the solution from perforated lead or rubber pipes laid on the bottom of the vats. Another method consists in pumping the solution from the bottom of one end of the vat and discharging it in such a manner as to create a circular motion. Another method consists in mounting the anodes on spindles and revolving them slowly in the solution between the cathodes. By another and very effective method a horizontal rod is made to travel up and down between the anode and cathode. The latest and, it is claimed, the best method is briefly described as follows: A large perpendicular cylinder is made to revolve slowly in the solution. The cylinder is surrounded by anodes and to the periphery of the cylinder the cathodes are attached. In operation the cathodes are constantly passing the anodes and the disturbance is so effectual that 200 or more amperes per square foot may be utilized without burning the deposit.

**ALKALINITY AND ACIDITY.**—An excess of acid or alkali in a nickel solution may be instantly detected by dipping simultaneously into the solution strips of blue and red litmus paper. If the blue litmus paper becomes red, it indicates an excess of acid, while on the other hand the test shows that when red litmus paper becomes blue an excess of alkali is indicated.

**ALLOY, FUSIBLE.**—Melt 1 pound of lead in a clean vessel, and stir in  $\frac{3}{4}$  pound of tin and, finally,  $1\frac{1}{2}$  pounds of bismuth. Stir well, and thoroughly incorporate the mixture; pour out gradually into water; collect, and repeat until a complete admixture is obtained. It melts at  $212^{\circ}$  F., the temperature of boiling water.

**AMALGAMATION OF ZINC.**—To amalgamate zinc plates it is necessary, first, if the plates be new, to wash them in hot caustic soda solution, so as to remove the greasy film imparted to them at the rolling mills. A flat vessel is then partially filled with dilute sulphuric acid and upon it is also poured a little of the best quality of mercury procurable. The plate is dipped in the liquid and the mercury rubbed on with a pad of tow or other suitable substance. The workman should take particular care to cover every portion of the surface. When the plates present a uniform silvery appearance they may be set upon edge to drain, after which they are ready to be placed in the battery.

**AMMETER? WHAT IS AN.**—Without going into technicalities, it may be said that the ammeter is an instrument for measuring the amount or quantity of electric current employed in performing work. The ammeter measures quantity, while the voltmeter measures pressure, and the product of quantity multiplied by pressure, as measured by these instruments, is called watts and is what we who buy electric power have to pay for at the end of each month.

**AMMETER VARIATION.**—The ammeter reading may vary from two causes on a constant surface (cathode) load without the voltmeter varying. The resistance of the solution

may vary or the resistance between the supporting or case rods and the tank rods may vary. Another reason, probably the best, is that a new case when immersed presents a large resistance, due to the lack of copper on the surface. A new case will not use full current density for some minutes after it is immersed. In fact, the current for the first few seconds is almost nothing. If you have a large number of fresh cases, and a few that are nearly done, your current will perhaps be fifty per cent low with no voltmeter change. Bad brush contact would vary voltmeter and ammeter together.

AMMONIA.—Is water saturated with ammonia gas. Must be stored in closely stoppered bottles. It is employed for neutralizing nickel solutions when too acid and is sometimes added to soldering fluid.

AMPERE.—The unit of current strength is produced when an electromotive force of one volt acts through a resistance of one ohm and conveys one coulomb per second. An ampere is that strength of current which will deposit .00508 grain of copper per second from a blue vitriol solution.

ANCHORING ELECTROTYPES AND HALF-TONES.—Bore several holes through the base and countersink both sides. If the plate has been finished long enough to have become oxidized, brighten the back by filing and then lay it on the block and secure it temporarily by hand clamps. Apply a small quantity of soldering fluid to the plate through the holes and then pour in melted solder until the holes are full. It is important, of course, not to get the solder too hot, as in that case there would be danger of melting through the plate. There is always an element of uncertainty in securing plates by anchoring, but in some cases there is no other way to accomplish the object.

ANODE.—The pole or plate by which an electric current enters a depositing solution. In electrotyping a solid plate of copper of any convenient thickness and about the same area as the cathode or mold, it should be connected with the positive pole of the battery or dynamo and kept clean by occasional scouring and washing.

**ANODE CONNECTIONS.**—A new anode connection recently introduced consists of a broad strap of copper about three inches wide and one-eighth of an inch thick, accurately milled where it hooks over the rod so as to make a perfect connection. The strap is secured to the anode by a casting of electrotpe metal which covers and protects the connection from the action of the solution. The anode may, therefore, be suspended entirely under the solution without danger of destroying the connection, which is practically everlasting. In addition to the advantage of having a perfect connection, the anodes wear away evenly, leaving no stub ends to go in the junk pile or be worked off in the baskets.

**ANODE HOOKS.**—Anode hooks should be of ample dimensions to carry a large volume of current without heating. Copper wire of three-eighths of an inch in diameter is recommended. The hooks should be kept clean where contact is made with anodes and cross rods, to insure minimum resistance.

**ANODE PLATES, SIZE OF.**—The anode and cathode should each present an equal surface to the solution. The anode has two sides, but the back, when facing flat work, should be left out of account. Hence an electrotpe a foot square should be faced by an anode a foot square. If there be any difference in size, the anode should be the larger.

**ANTIMONY.**—Antimony is hard and brittle and melts at 842° F. It is not attacked by cold sulphuric acid. It is employed with lead and tin in the manufacture of electrotpe and stereotpe metal to harden the mixture.

**"BACKER-UP," THE.**—Next to the molder, the backer-up is the most valuable man in a first-class foundry—that is, a good one that knows his business in regard to having his metal right and how to pour it on his shell with the least injury to the plate and to avoid shrinks. The responsibility of the backer-up is very great, and, if he does his work properly, he can save a great deal of time and labor in the finishing room.

**BACKING-UP PRESS FOR ELECTROTYPES.**—A patented device for backing up and straightening electrotypes consists of a bed frame supported by suitable legs and made long enough to provide room at its middle part for a yoke and vertically adjustable platen. At one side of the platen sufficient space is provided for the backing pan to set during the process of backing up the shell, and on the other side there is room for moving the finished plate out so that another pan may be placed in position at the left hand of the platen. The yoke and platen are somewhat similar to the yoke and platen of a stereotyper's drying press, except that the platen is provided on its under side with a layer of felt about one-fourth of an inch in thickness, and a press plate having projections or teats on its surface called a "hurdy-gurdy" plate. The hurdy-gurdy plate, with the intermediate layer of felt, is attached by bolts to the platen. The bed frame is provided with rollers to facilitate the passage of the backing pan from one end of the bed to its position under the platen, and from thence to the other end of the bed. In operation, the shell is placed in the backing pan on one end of the press, where it is backed up and cooled in the usual manner. The backing pan is then rolled under the platen and pressure applied by means of a hand wheel and screw, which has the alleged effect of straightening the face of the electrotype and bringing all parts of the same, by means of the hurdy-gurdy, into one plane, removing all unevenness and irregularities. It is claimed the intermediate layer of yielding material permits the hurdy-gurdy to give and adapt itself so it will not press any harder on the ends or sides of the electrotype than on the intermediate points. The inventor asserts that a great saving of time is accomplished by this method of straightening plates, as very little finishing is required.

**BLACKLEADING BY HAND.**—Blackleading by hand is a slow and laborious process and is seldom practiced, a machine being considered essential even in small foundries. For blackleading by hand, a camel's-hair brush is employed. The graphite should be brushed back and forth over the mold until

a bright polish is obtained and until it is certain that no spot, however small, has been neglected. If so much as a punctuation point fails to receive the proper polish, copper will not deposit thereon, and a hole in the shell will result. In the days before blackleading machines were invented, it was the custom to place the mold in a box provided at the front with a curtain. Then, by inserting the hand through a hole in the curtain, the polishing could be effected without filling the air of the room with dust.

**BLACKLEADING MACHINE, WET.**—The only wet leading machine is the one patented about twenty-six years ago by Mr. S. P. Knight, foreman of the electrotyping department of Harper Brothers. The machine consisted of a tank with a centrifugal pump, to which there was attached a hose and syringe. The tank contained a mixture of plumbago and water, of about the consistency of cream, which by means of the pump, was forced through the syringe, which was arranged to move to and fro across the tank and thus coat the molds, which were laid on a rack placed just below the surface of the solution in the tank. On moving the cases from the machine, the surplus mixture was scraped off with the hand, the cases being afterward thoroughly washed in another tank. The plumbago in the second tank was allowed to settle before the water was drawn off. This process gave promise of obviating much dust in the foundry, but never came into extensive use owing to the inability of workmen to operate it successfully, notwithstanding that Mr. Knight used it and no other method for coating his molds. In use it was found that, from the drippings from the cases after the water had dried out, there was nearly as much dust in the room as with the dry process.

**BLISTER ON SHELLS.**—Blister is sometimes caused by an excess of crocus on the mold; it will cause shrinks in the plates, making trouble for the finisher. Crocus should be used very sparingly, if at all, and should be carefully brushed off the mold before it goes into the vat. Instead of crocus, brush a small quantity of sulphate of zinc on the case before molding.

BOOK-PLATES, DEVICE FOR HOLDING.—When molding from beveled book-plates, make four wooden blocks exact size of the book-plates which are to be duplicated. Place them in chase, with wooden furniture at one end and one side, next to the chase. Place inverted brass rules around each block and a pica slug between the rules which are at the ends of the block where they meet in the middle. Lock up with Hempel quoins at one side and one end. Only one rule is necessary between the blocks the long way. The brass rules should have teats or lugs soldered on to catch the plates at the bevel to prevent them from lifting when wax mold is being lifted.

BRASSPLATING HALF-TONES.—Plating with brass is not an easy proposition for an amateur and is rendered unnecessarily difficult by the complicated solutions recommended by most writers. The following formula is simple and less troublesome to keep in order than those generally advocated: 16 ounces cyanid of potassium, 5 ounces carbonate of copper,  $1\frac{1}{2}$  ounces carbonate of zinc, 1 ounce ammonia and 1 gallon of water. The deposition of brass is usually attended with some difficulty because it is composed of two metals, one of which is positive and the other negative; hence the current strength requires more or less regulation to insure uniform deposition of both metals. As brass contains a larger proportion of copper than of zinc, the copper in the bath becomes first exhausted, and sufficient carbonate of copper must be added to restore the proper proportions. Cyanid of potassium must be supplied when the action of the bath becomes sluggish. A strong current is required. Constant watchfulness is necessary to keep the bath in good working condition. To increase the wearing qualities of zinc half-tones, the "Process Photogram" suggests facing the half-tone with brass, and recommends the following bath formula: Zinc carbonate, 10 parts; copper carbonate, 10 parts; soda carbonate, 20 parts; soda bisulphite, 20 parts; potassium cyanid, 20 parts; arsenious acid, 1.5 part; water, 1,000 parts. To make up the solution, proceed as follows: Take 12 parts sulphate of copper

and 12 parts sulphate of zinc, and dissolve them in water; then add carbonate of soda, already dissolved, to the solution. This precipitates the copper and zinc in the form of carbonates, a greenish-colored powder. Allow the precipitate to settle and pour off the supernatant liquor. Wash the precipitate and then mix in with the carbonate and bisulphite of soda in 900 parts water. Next dissolve the cyanid and arsenic in the remaining 100 parts of water and pour this into the first solution. This bath should be used cold.

**BRITTLE DEPOSIT.**—A weak current always and under all conditions causes the deposition of a harder and more brittle nickel than a current of medium strength.

**BRONZING SOLUTION.**—One gallon of water,  $\frac{1}{2}$  ounce sulphate of potash,  $\frac{1}{4}$  pint of ammonia. This mixture should be well heated. After the electrotype has been immersed, take it out and apply a wet scratch brush until the surface assumes a dark cherry hue, which is a favorite color with art lovers. A very beautiful bronze color may be imparted to copper articles, such as medals for instance, by boiling them in a solution composed of verdigris, 5 ounces; muriate of ammonia, 5 ounces; strong vinegar,  $\frac{1}{2}$  ounce. Mix the verdigris and the sal ammoniac by pulverizing in a mortar and then add a sufficient quantity of vinegar to form a paste. Now pour this into a copper vessel with a pint of water and boil for about half an hour. When cold, stand the mixture aside until the sediment has subsided, when the clear liquor may be poured off and bottled until required. The articles to be bronzed should be boiled in this liquor for ten minutes or longer, taking care that they do not come in contact during the operation. The fumes of hydrochloric acid or of chlorid of lime will produce a very good green bronze upon electrotypes, giving them the appearance of ancient bronze. The following process is recommended by Watt: "Electrotypes may be bronzed by suspending them in a wide-mouthed bottle (or other vessel) at the bottom of which a small quantity of sulphid of ammonium has been placed. The sulphid of hydrogen which escapes will give a good bronze tint to the copper in a

few moments, the depth of tone being regulated by the time of exposure."

**BURNING.**—An error is frequently committed in nickeling with too strong a current, the consequence being that the deposit on the lower portions of the objects soon becomes dull and gray-black, while the upper portions are not sufficiently nickeled. This phenomenon, which is due to the reduction of the nickel with a coarse grain in consequence of a too powerful current, is called burning or overnickeling. A further consequence of nickeling with too strong a current is that the deposit readily peels off after it reaches a certain thickness. This phenomenon is due to the hydrogen being condensed and retained by the deposit, which prevents thick deposition.

**CASES.**—Cases made of electrottype metal, cast in the backing pan and shaved down to about three-sixteenths of an inch in thickness, are superior in every respect to the expensive brass pans sold by manufacturers of electrotyping machinery. The soft metal may be easily kept in shape by planing down with a block of wood after each use.

**CASES, WARMING OF.**—Warming cases by laying them on the steam table, although quite generally practiced, is not a good plan, for it softens the wax next the case more than on the surface, and often results in concaved work. Cases should always be kept in a "hot box," the temperature of which should be so regulated as to keep the cases in proper condition for molding without additional warming.

**CASTING HARD SHELLS.**—It will be found that there is a great deal of difference in copper shells about the solder flowing readily. When a shell is extra hard the solder is invariably obstinate about flowing.

**CATHODE.**—Cathode is the pole or plate by which an electric current leaves a depositing solution. In electrotyping, the wax or composition mold which receives the deposit of copper. It is suspended from the negative pole of the dynamo.

**CIRCUIT.**—A circuit is the entire path of an electric current.

CLEANING BRUSHES, HALF-TONE.—Mr. E. R. Rodd, superintendent of the electrotyping department of the Butterick Publishing Company, is the inventor of certain half-tone brushes which are rapidly becoming popular with electrotype molders. Although these brushes are made of metal, the material is such that they may safely be applied to the most delicate half-tone without fear of injury. By the aid of these brushes, dirty half-tones may be thoroughly cleaned and all the original detail restored. Two brushes are employed. The ink or dirt in the half-tone is first softened with wood alcohol and then brushed out with the No. 1 brush. The cut is then covered with a soft rag and patted gently with the hand. After the cut is dry it is rubbed gently with the No. 2 brush, and again after the form has been blacklead until all the black lead has been removed.

CLEANING CUTS.—The molder will often receive forms containing dirty woodcuts, though not so many now as formerly, since the zinc line cuts and half-tones have to such an extent taken the place of the woodcut, but it will be well to know a liquid that will clean the woodcut nicely and which may be made as follows: To 1 quart of alcohol, add  $\frac{1}{2}$  ounce of bisulphid of carbon and  $1\frac{1}{2}$  ounces of strong liquid ammonia; thoroughly mix and apply with a brush as you would bezin. This wash will be found efficient in removing ink from a woodcut, or, in fact, from a half-tone. A good cleansing fluid, according to Dunton, is composed of alcohol, 16 ounces; carbon disulphid, 1 ounce, and strong fluid ammonia, 2 ounces. This may be used in the same way as benzin and will be found very effectual.

CLEANING ELECTROTYPE CASTS.—Scrub the casts while hot with kerosene oil and powdered pumice stone. Then lay the cast in a shallow sink with inclined bottom, and steam it out, using a steam hose without a nozzle. Then take the cast to a sawdust box and brush it thoroughly with clean, dry sawdust or lay it on a heated steam-table until dry.

CLEANING MACHINE, PLATE.—The Raisbeck Electrotype Company, of New York, has devised a machine for

cleaning electrotype plates, which is said to be superior to hand scouring and much more rapid. The machine "subjects the face of the plate to a current of benzine or other solvent or detergent simultaneously with gentle friction. We accomplish this by an apparatus which moves the plate to be cleaned backward and forward several times in contact with a moving brush of the proper soft material, adjusted sufficiently near to act in all the interstices. In the most complete form of the invention the brush is caused to reverse its motion on the plate and thereby to act more effectively in the recesses." The apparatus is the subject of letters patent No. 621,539.

**BLACK ELECTROTYPES.**—Seven pennyweights sulphate of barium, 1 quart of water. After the article has been immersed in the solution a light brown color is produced, which gradually deepens until it assumes an intense black. The object must be rinsed in hot water and then allowed to dry. To secure a brilliant polish, all that is necessary to do is to rub it with chamois.

**COLOR-PLATES, REGISTERING.**—Fasten the plates to the blocks by driving the nails only part way in. Then draw your nails, cut out the portions of the plates not wanted, and reblock the electros, using the same tack holes. This will insure a perfect register, provided your blocks have first been accurately finished to the same size.

**COLORING ELECTROTYPE MEDALLIONS.**—A very pleasing effect may be produced thus: Having well cleaned the electrotype, apply varnish with a soft brush to the base or flat surface, carefully avoiding the figure; when the varnish has become hard, attach a wire to the electrotype and place it in a gold or silver bath for a short time until sufficiently coated. Now remove the varnish and apply the bronzing material to the copper surface, and thus the figure will stand out in relief, either in gold or silver as the case may be.

**CONCAVE.**—This is almost invariably caused by overheating the backs of the cases, which softens the wax next the case more than on the surface. The temperature should

be uniform throughout. For this reason it is advisable to employ a "hot box," i. e., a box or cabinet heated by steam or gas and so arranged that the cases may be kept at just the right temperature for molding.

**CONDUCTIVITY OF LIQUIDS.**—The following is a list of the conductivity of a few liquids as compared with that of pure silver :

|                                             |                 |
|---------------------------------------------|-----------------|
| Pure Silver .....                           | 100,000,000,000 |
| Nitrate of copper, saturated solution.....  | 8,990           |
| Sulphate of copper, saturated solution..... | 5,420           |
| Chlorid of sodium, saturated solution.....  | 31,520          |
| Sulphate of zinc, saturated solution.....   | 5,770           |
| Sulphuric acid, 1.10 specific gravity.....  | 99,070          |
| Sulphuric acid, 1.24 specific gravity.....  | 132,750         |
| Sulphuric acid, 1.40 specific gravity.....  | 90,750          |
| Nitric acid, commercial.....                | 88,680          |
| Distilled water .....                       | 7               |

**CONDUCTIVITY, INCREASING.**—To increase the conductivity of a blackleaded wax mold, it is customary to precipitate a film of copper on its surface by the well-known method of first floating the mold with a solution of sulphate of copper and then sprinkling iron filings thereon. Another method consists in immersing the mold for a few moments in a solution of wood alcohol and phosphorus, afterward partially drying, then rinsing in running water and immediately suspending in the bath. This method is specially desirable for nickeltyping. The phosphorus solution is made by placing a few small pieces of phosphorus in a bath of wood alcohol and allowing it to stand for three or four days. Phosphorus is only soluble in alcohol, and the portion dissolved will be hardly perceptible, but will be sufficient for the purpose. While phosphorus is a dangerous substance to handle, on account of its inflammability when exposed to the air, it is perfectly safe if kept under water or alcohol, and the quantity employed is so very minute that no danger whatever need be apprehended from its use in the manner described.

**CONNECTIONS, GOOD.**—It has been frequently noted that electrotypers do not always appreciate the importance of making good connections. It is of no avail to provide large conducting rods and cross rods if the conducting capacity of

the rods is to be choked off at the points of contact, which is what occurs when one round rod is laid across another round rod. It is obvious that unless one or both of the rods is flattened where they come in contact, the area of the contact will be extremely limited compared with the area of the conductors on both sides of the contact.

**COPPER DISSOLVED BY SOLUTION.**—An electric current passing through a solution of sulphate of copper will dissolve copper suspended in the solution, whether it is in the circuit or not. This fact may be readily tested by weighing a small piece of copper and hanging it in the solution, without electric connection, and after a few hours weighing it again. It is because of this fact that extra anodes not in use, if left in the solution, will make it dense and heavy at the bottom and frequently cause the deposit to be spongy and granular.

**COPPER SCRAPS UTILIZED.**—Copper clippings and scraps may be utilized as an anode by packing them in a perforated lead box and suspending the box from an anode rod. The box may be constructed of plates of electrotype metal joined at the corners by soldering. It should be somewhat longer and deeper than your cases and about four inches wide. The perforations should be as near together as possible.

**COPPER, TO SEPARATE FROM WATER.**—There is a method called the "Cementation Process," which was employed a great many years, "for separating copper from the drainage water from mines containing copper in solution derived from the oxidation of mineral sulphids in the earth." By this process the water is brought into contact with scrap iron and its copper deposited by simple immersion. Under such circumstances the copper separates in little loose crystals termed "cementation copper," which contains nearly all the impurities of the iron used to precipitate it, and requires to be purified. Spain and Portugal export about half a million tons annually of iron pyrites containing several per cent of copper, the whole of which is extracted by this process.

**COPPER, WEIGHT OF.**—A copper shell .005 of an inch thick weighs about 3.71 ounces per square foot. One cubic inch of copper weighs 5.1585 ounces.

**CORROSION OF COPPER-FACED TYPE.**—In a dry atmosphere and under ordinary conditions, copper will not corrode to an extent sufficient to injure printing-plates, or type faced with copper, but there are certain colored inks which attack copper by reason of the mercury contained in them, and certain cleaning compounds containing ammonia which would be likely to produce corrosion if allowed to remain on the type. Verdigris may be removed from copper by brushing with very dilute nitric acid or ammonia and thoroughly rinsing with clear water.

**CORROSION, TO PREVENT.**—Copper soon loses its luster when exposed to the atmosphere, but the printing quality of the electrotpe is not impaired thereby. When electrotypes are stored in a damp vault or exposed to the action of acid fumes or gases which cause excessive corrosion, damage will of course result. The remedy is to remove the plates to a dry place. If such a place is not available, a coat of hot paraffin will protect them to some extent, or they may be given a coat of lacquer such as is used to preserve the luster on certain kinds of metal artwork. Most electrotypers would ridicule the idea of spending any time or money in an attempt to preserve the color of an electrotpe, and if they are carefully cleaned and stored in a dry place there is really no necessity for further protection.

**COST OF ELECTROTYPE SHELLS.**—The material in a tinned shell costs about .05 of a cent per square inch. The cost of molding and the various other operations involved in producing a shell are estimated to be about one-half the cost of the finished electrotpe. It is customary, therefore, to charge half price for shells. From the seller's standpoint this is a satisfactory method of estimating, but as a matter of fact the cost of the shells is considerably less than one-half the cost of finished book-plates. That is to say, the value of the metal in the plates, together with the labor of backing up and

finishing, is actually about two-thirds of the total cost of the electrotypes.

**COULOMB.**—A coulomb is the amount of current which passes through a conductor in one second when the strength of current is one ampere.

**CROCUS.**—Crocus is sometimes used to prevent the form from “sliding” and also to prevent the wax from sticking to solid cuts and causing them to be rough. If used at all, it should be carefully brushed off the mold before it goes into the vat, otherwise it is a frequent cause of “blisters” and “sinks.”

**CURRENT, HIGH TENSION.**—The incandescent light current will not answer for electrotyping or plating, because the tension is too high. The voltage of an electric light machine is 110 or more, while one to three volts is amply sufficient for electrotyping. There are other reasons, not necessary to explain, why the electric light current would be unsuitable for electrotyping.

**CURRENT STRENGTH.**—Current strength is the quantity of electricity which flows through any cross section of a circuit in one second of time; it depends on the electromotive force and the total resistance. The unit of measurement is called ampere (see Ampere). According to Ohm's law, the strength of current is equal to electromotive force divided by resistance. Current strength is measured by means of an ammeter.

**CURRENTS, MEASURING ELECTRIC.**—The ammeter is employed to measure electric currents, and the voltmeter to measure the electromotive force or pressure. Speaking of water flowing through a pipe, we would say that it is delivered at the rate of so many gallons per minute. The quantity would depend upon the pressure behind it and the friction of the pipe. So with the electric current; the number of amperes delivered depends on the pressure (E. M. F.) and the resistance of the conductors. If the pressure is one volt and the resistance one ohm, the current delivered will be one ampere

per second. If the resistance is only .01 of an ohm, the current will be 100 amperes per second. The current always equals the E. M. F. divided by the resistance. Inasmuch as the current depends on the resistance as well as the pressure, it is obvious that the voltmeter will not always accurately measure the current, for, while one volt pressure may produce 100 amperes under certain conditions of resistance, under different conditions the product may be more or less than 100 amperes; and, while one volt may produce 100 amperes, it does not always follow that two volts will produce 200 amperes, for increasing the pressure may increase the resistance by heating or polarization. A current of one ampere will deposit 18.116 grains of copper per hour, and as the ammeter is employed to measure the current after resistance has been overcome, its working value is always uniform. On the other hand, a current of one volt E. M. F. may deposit more or less copper at different times as the conditions of resistance vary. It is, therefore, evident that the true working value of the current can be measured only by the ammeter and can not be accurately measured by the voltmeter.

**CURVED ELECTROTYPES, CASTING.**—Many of the pages (all of the colorwork) of the *Chicago Blade* and *Chicago Ledger* are printed from curved electrotype plates which are cast by pouring the stereo metal directly into the tinned shell, in the same manner that a stereotype plate is cast from a paper matrix.

**CURVED PLATES, EXPANSION OF.**—The only way to prevent expansion in curved plates is to curve the shell and cast it in a curved box. Most electrotypers consider this an impractical method, although the writer knows of one large publication whose color pages are all printed from plates made in this manner. While it is obviously impossible to curve an electrotype without stretching it, the expansion may be minimized by surrounding the form with wide bearers and cutting down spaces so as to make the plate as nearly solid as possible. A form of open type matter will always stretch more than a solid tint or half-tone.

**DEPOSITION, ECONOMICAL.**—It is a waste of power to run the dynamo at a high voltage and prevent “burning” by cutting down the conductivity of the solution or increasing its resistance. It would obviously be in the interest of economy to make the solution as conductive as possible and adapt the current strength to the solution.

**DEPOSITION, RATE OF.**—One ampere deposits 18.116 grains of copper per hour; 10 amperes deposit 9.84 ounces in 24 hours; 386.4 amperes deposit 1 pound in 1 hour; 746 amperes deposit 1.93 pounds of copper in 1 hour; 17.94 amperes per square foot deposit .001 inch thickness of copper per hour.

**DURABILITY OF ELECTROTYPE PLATES.**—According to the *New York Times*, the greatest achievement in connection with the printing of “David Harum” was the part played by the plates from which the book was printed. Only one set has been used to print 425,000 copies. When certain signs indicated that “David Harum” was fast winning an extraordinary popularity, a second set of electrotype plates was made, to be used in case of emergency, but so well has the electrotyper done his work that this set has not as yet been pressed into service.

**DYNAMO, CHOOSING A.**—When making choice of a dynamo, it should be remembered that a certain volume of current is required to produce certain results. According to Gore, 17.94 amperes will deposit .001 of an inch thickness per hour on a square foot of cathode. A dynamo whose capacity is 360 amperes, or twenty times 17.94, will, therefore, deposit 20 square feet at a time at the rate of .001 of an inch per hour, or, to put it in another way, it will deposit 6,480 grains of copper per hour. By increasing the E. M. F. of the dynamo this weight of copper may be deposited .002 of an inch thick on 10 square feet of copper, or .004 of an inch thick on 5 square feet, or even .008 of an inch thick on  $2\frac{1}{2}$  square feet, but the limit of the capacity of the dynamo in weight of copper deposited per hour is 6,480 grains, and this limit can not be exceeded. It is obvious, therefore, that to perform a

large amount of work in a limited time requires a large dynamo. The best results which the writer has ever seen produced in an electrotype foundry were obtained from a 10-volt, 1,000-ampere dynamo coupled to three baths in series, and arranged in such a way that one of the baths may be disconnected when it is desired to hurry the work in the other two. Ordinarily the E. M. F. is  $3\frac{1}{3}$  volts per bath and the time required to deposit a satisfactory shell is from forty-five to sixty minutes, but this time may be reduced to thirty minutes or less by utilizing the entire pressure in two vats. This machine will deposit thirty feet of good shells per hour or about one hundred pounds of copper per day, and will take care of the product of four molding presses.

**ELECTROMOTIVE FORCE.**—The electromotive force of a current means that power by virtue of which it can surmount resistance. A current of low electromotive force may be entirely stopped or absorbed by a moderate resistance. A current of high electromotive force can overcome a high resistance or accomplish work in such a circuit.

**ELECTROTYPES, NEW METHOD OF MAKING.**—A sheet of thin metal, copper or an alloy of copper and some other metal, is laid on the type-form, which is then covered with a blanket and passed through a machine similar to a matrix-rolling machine. The blanket is then removed and a sheet of softened gutta-percha substituted therefor, after which the form is passed through the machine again. This gives a deep and sharp impression of the type in the sheet metal, which is now stripped from the form and backed up with electrotype metal. It is claimed that the plates obtained by this process are satisfactory except possibly in the case of very fine-screen half-tones.

**ELECTROTYPING IN AMERICA.**—According to the "Typothetæ and Platemaker," there are 372 firms in the United States and Canada who make electrotyping their sole business, and New York city has about ten per cent of them.

**FINISHING HALF-TONES.**—If half-tone shells are made extra heavy, there will be no necessity for using a

smasher in finishing the plate; in fact, little or no finishing should be required other than straightening. If punching is unavoidable, it is a good plan to employ a sheet of soft paper to protect the face of the plate.

**FINISHING VIGNETTED HALF-TONES.**—Before straightening the electro, take a punch of suitable shape and go around just outside the edge of the vignetting. This will have the effect of sinking the edge a little below the level. When straightening the plate do not bring up the edges of the vignetting, but leave it a little lower than the half-tone. The result will be that the print will shade off to nothing and give the soft effect of the original.

**FOREMAN'S SALARY, THE.**—There is a vast difference in foremen, just as there is among workmen. The ideal foreman possesses large executive ability, has a thorough knowledge of his business and has his employer's interests always at heart. He keeps his machinery in first-class working order and is as careful in expenditures as if the business were his own. He secures and retains the respect of his men and obtains from them their best efforts. He is prompt, accurate, energetic and courteous, and always a hustler. There are only a few of him. His services are in demand at good wages, and he is worth more than he gets.

**GUTTA-PERCHA MOLDS.**—If the character of the work is such that black lead is not objectionable, it may be used, in preparing for the bath, the same as on a wax mold. On molds of half-tones or steel engravings, the molds may be coated with silver. The following is an extract from a shop talk by Mr. G. J. Kelly, of London, England: "Gutta-percha is a product of the earth, and, in its natural state, is of a white color; it is gritty usually, and wants careful washing before manipulating. There are three kinds of gutta-percha in the market; the purest is white, the next brown, and the last or commercial article is black. The third-class article, for purposes in the trade, is the best. Of course there are various grades of black percha, and the choice is a difficult matter, known best to those who have had to try inferior material

through economizing. The percha should be about one-eighth inch in thickness and carefully rolled out in sheet. It should be hard and without any patches of 'brown' in its composition, because a good percha is always black and shiny as ebony after pouring. Now the next thing is its touch; it should be free from clamminess and dry to the finger. If there is a tendency to stick, you may reckon at once that the tar, or whatever foreign substance it contains, means trouble in store. When you have chosen your percha, it will suit your purpose best to cut it up into strips and then into squares of about four inches. It will not run down as wax when steam or heat is applied, and here begins the addition of fat. If you get English mutton fat, you have the very best article for mixing with gutta-percha. We now have selected our two principal materials, and we place in the same pan say four pounds percha and one pound fat. Then mix and stir the percha and fat together with a painter's knife say ten inches long. You mix and stir for some time, the longer the better, because all the air must be exuded. The plate to be duplicated must be absolutely free from dirt. The temperature of the plate should be hot enough to enable one to touch the plate with the fingers, and no more. You plunge the knife in and then take a portion of the percha on the blade from out of the pan, and pour exactly in the center of the plate, and this must be done to prevent airholes. We have now poured a mold, and we immediately remove the same from the heat to a cold slab for cooling. After the mold has set and cooled, I take it, press the edge of the mold gently down, the original upward, and, if I find the mold loosen from the corners, I gently lift the original off by means of a paring knife. If I find the slightest tendency in the percha to cling to the original, I give the mold another half hour. You may find that the mold may never come off; in other words, it will stick for all it is worth. Well, that is caused by pouring your material too hot or on a dirty original. If your mold has creases or airholes, it is cold material, and all this can be overcome only by experience. I face the mold by pouring and drying on the face a

solution of phosphorus and silver nitrate, which immediately gives it sufficient conductivity to cover the mold by an ordinary Smee battery in thirty seconds."

**HALF-TONES AND ELECTROTYPES.**—Half-tone shells should be made extra heavy, so that the pressure or weight of the metal will not distort them or force to the surface those portions of the shell corresponding to the high lights in the picture and which are a trifle low in the engraving. The same caution applies to the vignette. It is too much to expect that electros will be absolutely perfect. There is probably always some loss in reproduction, notwithstanding the claim of some electrotypers to the contrary. Sometimes the loss is hardly perceptible, but an expert will usually detect a difference.

**HALF-TONES INSERTED IN ELECTROTYPE PLATES.**—The method most commonly employed is to back up the etching to the thickness of the book-plate, then fit it into the plate and secure it by soldering. Mr. P. M. Furlong's process, which is patented, is described as follows: A base or blank block is fitted under the etching to make it type-high, and, having been properly trimmed to fit into the type-form, the etching is removed and the base alone is locked up in the form with the type. The removal of the etching is necessary in order that the type may be blacklead to cause it to freely release from the molding composition in the operation of molding, and it being preferable that the face of the etching should not be blacklead. After blackleading the type-form, the etching, having had its back thoroughly cleaned, is replaced face upward on the base within the form, with its face flush with the type, and then the surface of the molding composition having been coated with plumbago, the form is molded in the usual way. When the mold thus obtained is lifted from the form, the etching will be found imbedded in and adhering to the molding composition, face inward. The mold containing the etching is then blacklead in the usual way preparatory to being placed in the electrotyping bath; but, before being placed in the bath, the exposed back of the etching

should be freed from black lead and scraped bright to insure the incorporation of the electro-deposited metal with the back and edges of the etching and in order that the metal may be deposited in a continuous and unbroken sheet over the edges of the etching to the back thereof and thereby form a perfect union between the electrotpe and the etching, so that when the shell is removed from the mold it brings the etching with it, the two forming practically one plate, which, after having been freed from adhering wax or molding composition, may be backed with composition metal and finished in the same manner as ordinary electrotpe plates. By this simple, direct and economical process, an absolutely perfect incorporation of an etching plate with an electrotpe of reading matter is obtained.

**HALF-TONES, MOLDING.**—Molding half-tones requires considerable skill and careful attention to every detail of the process. The molding composition must be of a certain temperature, which can not be described but must be learned by experience; the blackleading, washing and coating should be performed with the utmost care, to avoid filling up the minute hatches of the engraving; and, lastly, you should not attempt to mold half-tones in connection with type. Mold them separately, and, after the plates are finished, insert the engraving in the page. It is impossible to learn electrotpe molding from written instructions. Skill comes only from long practice under the tutelage of an expert workman.

**HOLES IN SHELLS.**—Holes in the shells are due either to defective blackleading, failure to remove the air from the mold by thorough wetting before placing in the bath, or the use of a current so strong that it causes the formation of hydrogen gas on the cathode. Defective blackleading may be caused by a poor quality of graphite or insufficient brushing. The best way to wet the surface of the mold is to place it face up in a tank partially filled with water in such a manner that the mold will be an inch or two under the surface, and then direct a stream of water from a rotary force pump on to the mold. If trouble is due to the third cause, the

remedy is to reduce the speed of your dynamo or use an agitator. The latter is by far the best plan, as the agitator will not only dissipate the gas bubbles but will enable you to employ a current twice as strong as would be practicable with your solution test, and thus double the rate of deposition.

**HORSE-POWER.**—One horse-power equals 746 watts. The unit of electric output: 1,000 watts equals 1.34 horse-power; 1 horse-power equals 746 amperes—with 1-volt pressure causes 1.93 pounds of copper to be deposited per hour.

**HOT BOX, DUNTON'S.**—The cabinet consists of two boxes, one built inside of the other and having an air space between them. The outer box should be constructed of heavy material, or, better still, of two thicknesses of board, with a lining of thick asbestos board between the wooden walls. This keeps all the heat on the inside. Both boxes should be built practically tight; that is, do not bore any holes through the walls of the inner box to communicate with the heat space between the boxes. This is unnecessary and a detriment to the satisfactory working of the cabinet. The radiating space between the outer and inner boxes should be at least six inches; that is, the walls of the inner box should be placed six inches from those of the outer, on the top, ends and sides, while on the under side there should be at least eight inches, and the floor of the inner box should be made of two thicknesses, with a layer of asbestos paper between them. The heating coils, consisting of six lengths of  $\frac{3}{4}$ -inch steam pipe, should run lengthwise of the cabinet and be placed under the floor or bottom of the inner box. There should be at least six inches between the top of the pipes and the floor of the inner box, and they should be supported on iron rods going through the walls of the outer box. The doors and their casings need special attention; they must not be made of a single thickness of wood, for this might spoil the satisfactory working of the whole affair. They should be constructed of two thicknesses of wood, with an air space between, similar to those on a refrigerator, and closed in on the sides, top and bottom, having holes of at least an inch in diameter bored at intervals on the

four sides, corresponding to the same holes bored in the casings, to connect the air spaces with the heat chamber of the cabinet. Both doors should be provided with springs, so that they will not be left open after molds have been taken out of or placed in the cabinet. The volume of heat can be regulated perfectly satisfactory by the manipulation of the valve in the steam pipe. The cabinet should stand up off the floor at least six inches, and be located handy to the wax shaver and filling tables.

INVENTIONS.—It is gratifying to note that inventors are taking up the subject of electrotyping and striving to produce more economical or more convenient methods of manufacture. The invention or discovery of a compound to satisfactorily anneal ozokerite may be mentioned as an indication of what may be expected in the way of improvement. A firm of Brooklyn chemists has just put on the market a soldering fluid, ready for use, which does away with the use of muriatic acid and the disagreeable and unhealthy process of “killing” it with zinc. Another inventor claims to have discovered a material which acts as a precipitant of copper to be used in the place of iron filings, thus eliminating all danger of scratching the molds. The electrotyping business is susceptible of much improvement.

IRON DEPOSITION OF.—Deposition of iron, except for the purpose of “steel facing,” is seldom practiced in this country, and there are probably not half a dozen establishments which are equipped for such work. In St. Petersburg, however, M. Klein has been very successful in producing electrotypes in iron, which are largely, if not exclusively, employed in the printing of state papers, documents, labels, etc. Some of these electrotypes, which were on exhibition at the Columbian Exposition, were very heavy and would indicate that there is no limit to the thickness which may be deposited with proper facilities.

LEVELING ELECTROTYPES.—In a recent patented process for leveling electrotypes, the method consists in introducing the backing pan and its contents into an air-tight

chamber and of forcing artificially cooled air into the chamber at a high pressure in order to cool and level the electrotype.

**LITMUS PAPER.**—Blue litmus paper is colored red by acid fluids, and red litmus paper blue, by alkaline fluids. By simultaneously dipping one-half a strip of blue and of red litmus paper in a solution, the reaction of the fluid can be judged from the change in color and the rapidity and intensity of its appearance.

**MEASURING INSTRUMENTS.**—Instruments for measuring electric currents should be included in the equipment of every well-ordered electrotyping establishment. In the early days of the art, it was sufficient to know that a current of some kind was at work and that in the course of time a shell of the desired thickness would be deposited. It might take twelve hours at one time and eighteen at another, but a few hours more or less was not considered of serious moment. With the modern electrotyper, however, every minute counts, and, as a rule, he employs all the current which can be utilized without "burning" the deposit. Having learned by experience what quantity may be employed to advantage, it is of great convenience to be able to measure the current and by means of the proper registering instruments maintain the pressure at the maximum point. The voltmeter and ammeter are also useful indicators of the condition of the solution. For instance, with the solution properly proportioned and the tanks connected in multiple, a pressure of  $2\frac{1}{2}$  volts should produce a current strength of about seventy-five amperes per square foot of cathode. If the ammeter registers less, it is an indication that the solution is deficient in acid.

**METALS USED IN ELECTROTYPING, MELTING POINT OF.**—Antimony,  $840^{\circ}$  F.; copper,  $1,196^{\circ}$  F.; lead,  $617^{\circ}$  F.; tin,  $773^{\circ}$  F.

**METAL ELECTROTYPE.**—Electrotype backing metal is composed of lead, tin and antimony. The proportions may vary somewhat. The most popular formula is: Lead, 90 pounds; tin, 5 pounds, and antimony, 5 pounds. However, 6

pounds of tin and 4 pounds of antimony, or 6 pounds of antimony and 4 pounds of tin, may be employed with good results. Electrotype metal fuses at about 600° F.

**METAL-POTS, CAPACITY OF.**—To calculate the contents of a round pot, multiply the cube of the diameter by the decimal .5236 and divide by 2, to find the number of cubic inches. To calculate the contents of a square pot in cubic inches, multiply the length, breadth and depth together. On account of the slope in the walls of the pot, the length and breadth measurements should be taken at a point equally distant from the top and bottom of the pot. A cubic inch of stereo metal weighs 6.15 ounces. A cubic inch of electro metal weighs 6.28 ounces.

**METALS USED IN ELECTROTYPING, SPECIFIC GRAVITY OF.**—Antimony, 6.70; copper, 8.889; lead, 8.01; tin, 7.3.

**MOLDING COMPOSITION.**—Most molders have their own opinion as to what constitutes the best molding composition. Possibly no two of them use exactly the same combination of ingredients, and yet all produce excellent results. Some of the best molders still use beeswax and decline to accept a substitute; others use ozokerite; others “crask” wax, which has ozokerite for a base; others a combination of ozokerite and beeswax, or “crask” wax and beeswax. All molding compositions are subject to changes, caused by repeated meltings and coolings, changes of temperature, etc. The skilled molder watches his wax and adds from time to time the material necessary to preserve its virtue. A good molding composition may be made by mixing together pure beeswax, 85 per cent; crude turpentine, 10 per cent; plumbago, 5 per cent. In summer add 5 per cent burgundy pitch. Ozokerite may be substituted for beeswax and is becoming popular as a molding composition. The following mixture is specially recommended by Mr. George E. Dunton: 10 pounds ozokerite,  $\frac{1}{2}$  pound vaseline and  $\frac{1}{4}$  to  $\frac{1}{2}$  pounds of white-pine pitch. If by long use the composition becomes hardened,

it may be annealed by adding from time to time a small quantity of vaseline.

**MOLDING COMPOSITION, ELASTIC.**—Dissolve 32 parts (by weight) of gelatin in 24 parts of water, over a slow fire; when dissolved, add 1 part beeswax cut up in small pieces. The mixture should be warm but not hot when used. Before applying the composition, the plaster casts should be well brushed with oil. The following composition is recommended by Mr. George E. Dunton: "Select 10 pounds of the best cabinetmaker's glue and put it to soak over night in 5 pints water. The semi-plastic mass should be heated over a water bath until it becomes of the consistency of thick syrup. To this mass should be added  $2\frac{1}{2}$  pounds of a good quality of molasses and 1 pound of pure glycerin, and thoroughly incorporated by stirring. The molasses and glycerin must not be added until within one-half hour from the time the composition is to be poured. Never try to make up this composition in a kettle sitting directly over the blaze of a fire." This composition is suitable for obtaining a reverse mold of objects which may not themselves be suspended in the bath. When the mold has been obtained, a duplicate of the original should be made by pouring wax into the elastic mold. This wax cast may be suspended in the bath and deposited upon, thus securing a metallic reverse upon which a duplicate of the original may be deposited.

**MOLDING PRESSES, HYDRAULIC.**—The hydraulic molding presses in one of the larger electrotyping establishments in New York are operated by accumulators, in which a pressure of 1,000 pounds to the square inch is maintained by a suitable pump. When the pressure in the accumulators reaches one thousand pounds an automatic governor stops the pump, which starts again when the pressure is diminished by reason of the operation of the presses. Pressure is applied to the presses by simply turning a valve, and, as the pressure is continuous, the travel of the press bed is much more rapid than is the case when the pump is attached to the press. The plant would be considered very expensive by most electrotypers, and

for that reason this method of molding is not likely to become popular.

**MOLDING WAX, TO SOFTEN.**—A new composition for softening wax which has become dry and brittle has recently been put on the market and is sold by dealers in electrotyping supplies. It is called Ozo Compound, and is highly recommended by many electrotype molders.

**MOLDS, BLISTERED.**—Blisters are sometimes due to moisture in the wax. It may be due to adulteration. The trouble may be partially remedied by burning down the case before molding. Skimming the case with a hot wire will also help to remove the moisture.

**MOLDS, COATING.**—When spots appear on the molds which do not coat readily, the difficulty may be due to the fact that the mold has not been thoroughly wetted, and may be remedied by using stronger alcohol or a more powerful stream of water. Greasy iron filings might also cause the trouble.

**NICKEL ELECTROTYPES.**—To deposit nickel on wax molds, blacklead the mold in the usual manner and increase the conductivity by floating the surface of the mold with a solution made by dissolving phosphorus in wood alcohol to saturation. After floating the mold with the phosphorus solution, rinse in running water and repeat the operation. Mold will cover in five minutes, and, after ten minutes, may be removed from the bath, rinsed and immediately placed in the copper bath. An interesting invention comes from Louis Boudreaux, of Paris, France. In order to produce electrotypes in nickel, he covers the wax (before taking the impression) with powdered bronze, the coating with graphite being omitted. In this way he secures a surface of wax that, when placed in the bath, will permit the adhesion of the nickel and result in the quick building up of a shell. As is well known, if electroplating is undertaken with nickel, after the manner of copper, the small amount of adhesion of the nickel to the graphite often causes a failure. The inventor further claims that a

metallic surface, as of bronze, on the wax is much better for electroplating with any metal than is the plumbago surface.

**NICKEL-PLATING ELECTROTYPES.**—In printing from electrotypes with colored inks, more especially with inks which are prepared from a mercurial pigment, such as red, brown or vermilion, not only is the surface of the electrotype injuriously affected by the mercury forming an amalgam with the copper, but the brilliant colors are also seriously impaired by the decomposition which occurs. To avoid this, it is best to give electrotypes to be used for such purposes a coating of nickel, which effectually protects the copper from wear and the action of the mercury, and seemingly brightens the color of the ink. It is absolutely necessary that the face of the electrotype should be chemically clean, in order that the nickel deposit may adhere to the copper. After printing-plates have been nickeled, they should be rinsed in clear water, then plunged in hot water and dried in sawdust. It is claimed that nickeled plates will take ink better if they are also brushed with fine whiting.

**NICKEL-PLATING HALF-TONES.**—There appear to be conflicting opinions regarding the nickel-plating of half-tones, the usual impression being that the cut becomes filled up. While this may be true to a certain extent, the effect so produced is far less than is generally supposed. This may be determined by depositing a good plating of nickel on one portion of a first-class electrotype and comparing the plated and unloaded portions under the microscope. Some nickel-plated electrotypes, made for the purpose of determining this point, appeared to be equally as sharp as nickeltypes from the same originals, the amount of nickel on the plated cuts being considerable, .001 inch or more, as judged by the time and current. The reason of this may be found in the fact that nickel deposits in a very smooth condition, and that the current densities during plating being greater at points nearest the anode, more metal would be deposited upon the printing surface than in the depth of the dots, thus, if anything, increasing the depth of the half-tone plate. Deterioration, if any occurs, would

seem to be due to a decrease in the diameter of the dots in the half-tones and the accumulation of nickel on the high-light points, causing the impression in printing to be darker. In practice, it is doubtful if such an effect could be noticed.

**NICKEL SOLUTION.**—The following formula is recommended by Dunton: To make a solution in which nickel will be deposited as near faultlessly as it is possible in an alkaline bath, the proportion of the nickel-ammonium sulphate should be  $\frac{1}{2}$  pound to the gallon of boiling water, and make this volume of water slightly less than the bulk of the desired solution is to be. If the solution is to be 12 gallons, dissolve 5 pounds of the sulphate in 10 gallons of boiling water, stirring until the sulphate is all dissolved; then strain off into the tub, and add 2 gallons of cold water. Allow it to stand until the temperature has fallen to  $70^{\circ}$ , and test with the hydrometer. If it registers  $5^{\circ}$ , or even a half degree less, it is in condition to work; but if more than that, it must be reduced with cold water to that point, to obtain the best results. Outside of the advised addition of certain organic acids, certain theorists have recommended the addition of all kinds of nitrates, sulphates, carbonates, citrates, sodium, magnesium, potassium and calcium chlorids; but, as the result of my personal experiment, I would advise the reader to leave them all entirely out of his prospective nickel baths. The results without their addition will be far more satisfactory. The nickel bath will be found quite a troublesome customer to keep in sorts, as it is supposed to be kept at a state of neutrality that is neither alkaline nor acid; if either, I believe it should show a very slight acid reaction. This state may be tested for, and proved, by the ordinary "litmus paper," which should be always kept handy to the tub. Either the blue or red will answer the purpose equally well. If the red is used, first dip in strong ammonia, which will turn it a deep blue, proving that the ammonia is strongly alkaline. Allow the paper to dry (it will retain the blue color); now dip it in the solution and allow to dry. If, upon drying, the color has changed to a reddish purple, between the red and the blue,

in which neither predominates, the solution will yield the best results. If it should turn a reddish tint as soon as drawn from the liquid, rest assured there is too much acid in the solution, and the deposit will peel. If the paper retains its blue, the solution is too alkaline and will yield a deposit which will prove too brittle or hard. A very slight reaction toward the red is prolific of the best results. If the solution becomes too acid, the addition of a small quantity of ammonium sulphate will correct the fault; if too alkaline, the nickel sulphate. Consequently, it is an easy matter to keep the contents of the solution constant. A simple bath, which has been thoroughly tested in some of the largest electrotype foundries in the country, is made by dissolving the double sulphate of nickel and ammonia in warm water, in the proportion of three-quarters of a pound of the salts in each gallon of water. The procedure is the same that has been recommended for the copper solution, i. e., the salts should be suspended in cheesecloth bags just under the surface of the water until entirely dissolved, when the solution should be thoroughly stirred, and is then ready for use.

**NICKELTYPES.**—Nickeltypes possess three principal advantages over electrotypes for half-tone reproduction: First, they are much more durable; second, they take ink better, particularly colored inks, and, third, the method of their manufacture is such that there is less danger of scratching or injuring the mold than in the ordinary methods of electrotyping. Probably the chief advantage of the nickeltypes is found in the fact that it is not affected by colored inks, although due consideration should be given to the other points mentioned.

**NICKELTYPING.**—The proper anodes for the purpose are so hard that they are subjected to 4,000 degrees of heat in casting, and, when coming in contact with the sand, a thin scale or coating is formed on the outside, which causes irregular deposit and gives the anode the appearance of being veneered or plated. This outer covering also contains an indefinite quantity of iron (carbon), which, if liberated in the solution to an excessive degree, will stratify the latter to an

extent of causing endless trouble. Where this iron oxid comes in contact with the cathode before the shell is perfectly formed, further development is checked, and the next deposit, or backing, comes through to the face, giving a faulty plate, the surface either being rough or copper specks and spots showing through. If this same oxid is allowed to dry or adhere to the nickel shell after it is perfectly formed, the copper or tinfoil will not unite perfectly, and the shell will be lost and blister or peel off. These are the genuine blisters, and should not be confounded with the so-called globular and irregular blisters that arise when depositing the nickel shell. These are not blisters, but, more properly, gas-blows, caused by the current, solution, anode and cathode surface exposed not harmonizing. A certain amount of effervescence during deposition is necessary to insure quick, bright and perfect deposit; too little retards the work; too much produces the defects mentioned, which are next to impossible to eradicate after the shell is backed up, especially in half-tones.

**NICKELTYPING, CONNECTIONS FOR.**—In depositing nickel on wax molds, it is desirable that the mold shall be covered as quickly as possible. To promote this end, it is well to extend a loop of wire entirely around the mold, sinking it into the wax and having it long enough so that the ends may be bent into hooks for suspending the mold in the bath. By observing this method, deposition will begin on all sides of the molds at once, instead of beginning at the top and spreading down over the entire length of the mold, as is the case when the ordinary electrotyping connection is employed. With the loop-wire method, the mold will cover in from two to three minutes.

**NICKELTYPES, DEFECTIVE.**—Depressions in the face of nickeltypes plates are due to gas bubbles, caused usually by too strong a current. Nickeltyping is not an easy proposition, and, to be successful, all the conditions must be just right. The current and solution must harmonize. To ascertain the proper strength of current is a matter of experiment, and for this

purpose depositing apparatus should include a rheostat, by means of which the current may be varied at will.

**OZO COMPOUND.**—The quantity of ozo compound to be added to the molding wax or ozokerite varies with the season of the year and the condition (or quality) of the wax. Start with from one pint to one quart to each fifty pounds of wax, adding more until the wax is soft enough. Most of the ozokerite in use is of inferior grades. The less pure ozokerite is the more crude oil it contains and the lower its melting point, requiring less ozo compound. Beware of an overdose, as it takes some time to get the wax into shape in case of an overdose. The best molds are made with pure ozokerite reduced with ozo compound. Never heat the forms, and use cold cases or molds. In lifting forms out of the mold, give a steady, strong pull. The form will not release quite so easily from a cold case as from a heated case, but the results will be better from the cold case.

**OZOKERITE, TO SOFTEN.**—When ozokerite molding composition becomes hard and brittle, add vaseline, or ozo compound, a little at a time, until it becomes sufficiently soft and plastic.

**OZOKERITE, TO HARDEN.**—In hot weather, if the composition becomes too soft, add a very little of pine turpentine.

**PATINA, IMITATION OF GENUINE.**—Repeatedly brush the objects with solution of sal ammoniac in vinegar, the action of the solution being accelerated by the addition of verdigris. A solution of 9 drams of sal ammoniac and  $2\frac{1}{4}$  drams of potassium binoxalate, in 1 quart of vinegar, acts still better. When the first coat is dry, wash the object and repeat the manipulation, drying and washing after each application, until a green patina is formed. It is best to bring the article, after being brushed over, into a hermetically sealed box, upon the bottom of which a few shallow dishes containing very dilute sulphuric acid and a few pieces of marble are placed.

**PEELING, TO PREVENT.**—The great difficulty in nick-typing is peeling of the deposit before a sufficient thickness has been attained. To prevent peeling, the solution and the current must be of just the right strength. To enable the operator to work intelligently, a voltmeter and a rheostat should be included in the circuit. The current may then be suited to existing conditions and varied at the will of the workman. Nickel is a somewhat obstinate metal to deposit, and requires careful attention. It will not adhere to surfaces which are not absolutely clean, and even then will peel if left in the bath too long, or if deposited with too strong a current. The printing surfaces which are to be nicked should be scrubbed with hot lye or brushed with lime paste, and then thoroughly washed in running water, after which they should be immediately suspended in the bath. They should not be allowed to dry or be touched with the hands; with a current of two to three volts tension, fifteen or twenty minutes in the bath will be sufficient. The plates should be separated from the anode by a distance of six or seven inches.

**PINHOLES.**—Shells which are defective by reason of “pinholes” are very annoying. The usual cause is insufficient blackleading, or failure to blow out the lead thoroughly after the mold has come out of the machine. There are other causes, however, among which may be mentioned the formation of gas bubbles in the depressions of the mold, and an insufficiency of acid in the solution when working with a very strong current. The second cause may be remedied by employing an agitator. The remedy for the first and third causes is self-evident.

**PLATING WITHOUT A BATTERY.**—Simple immersion of an iron article in an ordinary solution of copper sulphate, such as is employed in electrotyping, will produce sufficient action, chemical or electrolytic, or both, to form a very thin coating of copper on the iron. Steel pens, needles, etc., are coppered by revolving them in a tumbling-box with sawdust moistened with a solution made by dissolving  $1\frac{3}{4}$  ounces of blue vitriol in 10 quarts of water, and adding  $1\frac{3}{4}$

ounces of pure sulphuric acid. Brush coppering is executed as follows: The utensils required are two vessels of sufficient size, each provided with a brush. One vessel contains a strongly saturated solution of caustic soda, and the other a strongly saturated solution of blue vitriol. The well-cleansed object is first uniformly coated with the caustic soda and then with the blue vitriol. A quite thick film of copper is immediately deposited. Care must be taken not to take the brush too full, and not to touch a second time the place once gone over, as otherwise the copper will not adhere firmly.

**POSTAGE STAMP PLATES.**—The United States postage stamps are printed on a steam press, from steel plates, and not from electrotypes. The original is engraved on soft steel and then casehardened, and this hardened die or original is pressed into the rim of a soft steel roller, which is also casehardened, and from this hardened roller any number of duplicates are made on soft steel, which are again hardened before printing.

**RAPID ELECTROTYPING.**—Mr. J. A. Corey, manager of the electrotyping department of His Majesty's printing-office, claims to have invented a depositing apparatus which enables him to successfully employ 220 amperes per square foot. No more time is required to prepare the mold for the bath than is usually necessary. He hopes soon to be able to give the trade full particulars of this depositor. The full significance of Mr. Corey's announcement may be realized when it is remembered that the average electrotyper employs from forty to seventy-five amperes per foot. Mr. Corey's invention, if practical, would reduce about two-thirds the time at present required for depositing.

**RESISTANCE.**—Resistance is that quality in an object which prevents more than a certain amount of current passing through it in a given time, when impelled by a given electromotive force. The resistance of a conductor is equal to the time required for a unit quantity of electricity (i. e., a coulomb) to pass through it, while its two ends are maintained at a unit difference of potential, i. e., at one volt. The unit

of resistance is termed an ohm. The resistance of liquids as compared with metals is enormous, the resistance of a saturated solution of blue vitriol being 16,885,520 times greater than copper. The resistance of a wire is directly proportional to its length, and inversely to its sectional area or weight, per unit of length. Conductivity is the reverse of resistance. By rise of temperature, the conductive resistance of metals is increased, and of electrolytes is decreased; thus warm solutions facilitate deposition.

**RESISTANCE BOARD.**—The switchboard, or resistance board, consists of a number of metallic spirals, usually of German silver, arranged on a board in such a manner that one or more of them may be switched into the circuit, thus presenting more or less resistance, as may be desired, to the passage of the current.

**REVERSE ELECTROTYPING.**—To prevent the deposit from adhering to a metallic matrix, clean the matrix thoroughly and then flow over it a very weak solution of potassium sulphuret. An impalpable film will effectually prevent adhesion of the deposit. This process is found very useful in the production of reverses and in the manufacture of embossing dies.

**SAWS, CARE OF.**—Royle says: If new saws do not run true sideways, get the manufacturers of them to remedy the trouble. The eye of the saw should always fit the mandrel nicely. Never use a hammer on the spindle nut — a wrench is provided especially for this nut. A piece of emery wheel or grindstone is good for truing up a saw. Do not use a saw that is out of round. See that every tooth in the saw cuts. To set a saw truly, much care is needed. Avoid too much set. Set over only the points of the teeth. Use as little set as possible. Never use a nail punch for setting. Work with a sharp saw. Don't be stingy with saws; keep an assortment. Specially good workmen should have saws for their special use. Change saws to suit the work required — remember that this can be readily done. The smaller saw that is suitable is the preferable one to use. A sharp, true saw is required for

good work. A dull saw is a dangerous one. Avoid a high ripping gauge, or fence, when a low one will answer. Before ripping stuff, try the ripping gauge to see if it is parallel with the saw. A good test of this is to rip a short piece to a width, and see if, as it passes through, it just glides along the edge of the saw-blade, touching it lightly. Adjust the table top so that the saw will just reach through the stuff. While sawing, keep your eyes on your work. Use great caution, but avoid timidity. A smoking saw needs sharpening. Flying smoke means trouble for the saw. Burnt and buckled saws indicate carelessness. A buckled saw is a bad one. Screeching saws have long teeth. Avoid high or long teeth. Joint off the saw frequently, and, when you do so, remove it to the clamps for filing. File straight across. In filing, first sharpen the face or front of the tooth, then file off the back of the same tooth. Save time by filing from one side. Different persons should not file the same saw. Why use a fleam-toothed saw for crosscutting when a fine-tooth rip will answer? Try it. Fleam teeth are unnecessary except for special work. Too thin saws will screech and run. A good sawyer is known by the saws that he keeps. Avoid a worn throat-piece—renew it frequently. Most accidents arise from carelessness. Have the belt-shifter work freely; control it with the foot. It is essential that the belts be even in thickness throughout their entire length. The spindle belt, at least, should have no rivets or lacings; all joints should be lap-glued or cemented.

**SERIES, ELECTROTYPING IN.**—There is no object in connecting two tanks in series unless you use twice the E. M. F. you would on one tank. The primary advantage in connecting tanks in series is found in the general principle of electric distribution—that a given amount of power or energy is conveyed more cheaply at a high pressure than at a low pressure. Next, it is easier to build a machine of a given capacity for high pressure and low current than for low pressure and high current. The current capacity of a dynamo is determined by the cross-section of the armature conductors. A four-pole armature wound with  $\frac{1}{2}$ -inch copper rods has a

capacity of 1,500 amperes. It will get too hot on a high current. Suppose you are working quiet solutions: 1 volt is enough E. M. F. per tank, and 20 amperes per square foot of cathode, we will say, is the current required. If this 1,500-ampere armature is revolved in such a field and such a speed as to develop or generate 1 volt, it is evident that tanks in parallel only can be used—or one big tank. The surface that can be covered at a maximum rate is 1,500 divided by 20, or 75 square feet. If, however, this same armature be revolved in such a field and at such a speed as to generate 2 volts, its current capacity will in no wise be affected, and you can use the current twice over, consuming 1 volt in its first passage through the solution, and the remaining 1 volt in its second passage, and so on. If a 1,500-ampere armature be revolved in a field which will produce 10 volts, a corresponding number of tanks can be operated, each depositing for a maximum on 75 square feet of surface. A water-power may, perhaps, give a simple analogy. Suppose 1,000 cubic feet per minute is flowing in a given stream. It is evident that, with 20-foot fall or head, twice the work can be accomplished that can be with a 10-foot head. From the fact that the E. M. F. of an armature is dependent on three things, namely, turns of armature, strength of field, and velocity, it follows that an armature built for 1,500 amperes and 1 volt can not be used for 1,500 amperes and 5 volts, without making an enormously large field and running it at a prohibitory speed. Therefore, a change in E. M. F. above 25 per cent, on small, slow-speed machines, demands a rearrangement of parts and different windings. There is no object in taking a dynamo of 3 volts or less and putting it on two tanks either in series or in parallel, for, if the solution be agitated, the entire 3 volts may be used in one tank.

**SILVER ELECTROTYPING.**—Silver is occasionally used in special cases for copying works of art or even valuable engraved steel plates. Ordinary wax and gutta-percha molds, such as are used for copper electrotyping, are not admissible for silvering, because they are to some extent attacked by the

cyanid solutions. The simplest method of obtaining replicas of works of art in silver is to obtain, first, a thin electrotype shell of copper from the intaglio mold, and then to deposit silver upon this in the cyanid bath. The copper protecting film may be of the thinnest, so that it shall not destroy the sharpness of the lines, but it must, of course, be subsequently removed, after the required thickness of silver has been deposited, and the whole electro separated from the mold. This solution of the copper may be effected by treatment with warm hydrochloric acid, or, better, with a warm solution of iron perchlorid, either of which will attack the copper but leave the silver untouched. On the removal of the copper, the pure silver surface has the required form in practically undiminished sharpness and brilliancy. The silver may be built up to a thickness of one-eighth of an inch or more. It is seldom, however, that this process is required, and practically the sole application of electro-silvering is to be found in the coating of other metals to endow them with properties which they do not themselves possess.

**SILVERING SOLUTION FOR GLASS.**—(1) Nitrate of silver, 1 ounce; water, 10 ounces; add liquid ammonia until the brown precipitate is redissolved; then add 90 ounces water. (2) A 1 per cent solution of formaldehyde. Mix two parts of 1 with one part of 2. Flood the surface to be silvered. In fifteen to twenty minutes wash in running water.

**SOLUTION, CONDUCTIVITY OF.**—It should be remembered that the solution is a conductor of the current in the same sense that the rods are, and should be considered in that capacity as well as a dissolving medium. Pure sulphate of copper solution is an extremely poor conductor. The addition of sulphuric acid improves its conductivity, but under the most favorable conditions its resistance is several millions of times greater than copper. To reduce this resistance to a point where the liquid will not become appreciably heated by the passage of a strong current, it is necessary to provide an exceedingly large area of conducting fluid and to suspend the anodes and cathodes as near together as possible, say two or

three inches apart. According to Joule's law, the development of heat will be greater the smaller the cross section of the conductor and conducting capacity are, and the larger the quantity of current which passes through it. If, therefore, it is desired to employ a very strong current, the vat must be larger in proportion to the size of the anodes than would be necessary with a moderate current.

**SOLUTION, COPPER, HOW TO ASSAY.**—There are two ways of measuring the content of copper in a solution, both of which require accurate instruments and the facilities of a laboratory. The simplest and best method is that of electrolysis. A very delicate and accurate scale is required, capable of measuring 1-100 of a grain. The process is described by McMillan as follows: "A platinum dish about three-quarters of an inch to an inch in height, and about three inches in diameter, forms a convenient cathode, at once holding the solution and receiving the deposited metal. The anode consists of a circular plate of stout platinum foil about  $2\frac{1}{2}$  inches in diameter, with several perforations to allow gas to escape from beneath it. The platinum sheet is fastened horizontally, without solder, to the end of a vertical platinum wire, attached to the positive pole of the battery, the platinum dish making contact externally with a copper wire attached to the negative pole. Instead of this, a cylinder of platinum foil may be used as a cathode, being suspended with its main axis vertical within a small beaker, the anode consisting of a coil of platinum wire placed within the cathode. The object of the electrolysis method is to continue the action of the current until every trace of copper is precipitated on the platinum cathode, and, as the latter should have been weighed previously, the increase of weight shown after deposition gives the number of grains of metal in the quantity of solution taken. It is possible to separate every trace of copper from the solution, so this method may be made to give absolutely accurate results. Half an ounce of the liquid may be employed, and electrolysis is continued until the liquid is decolorized and a

drop removed from it strikes no blue color with an excess of ammonia."

**SOLUTION, HOT, REMEDY FOR.**—Heating of the solution is caused by resistance. This is always the cause of heat, and the way to minimize resistance is to increase the capacity of the conductors. The solution is a conductor of the current from the anode to the cathode. It is a very poor conductor, however, as all solutions are, and must, therefore, have a large area to compensate for what it lacks in quality. Under ordinary conditions the cross-sectional area of the solution should be at least twice as great as the area of the anode; with a very strong current, the cross-sectional area of the solution should be at least three times that of the anode. In other words, if the anode is 15 by 20 inches, the vat should be 32 inches wide and the solution 28 inches deep. A current of sufficient strength to deposit good shells in one hour requires large conductors, and this applies not only to the copper rods but to the solution, which is also a conductor. Moreover, the solution is a very poor conductor, and what it lacks in respect of quality must be made up so far as possible in quantity. The cross-sectional area of the solution should be from two to three times the area of the case.

SOLUTIONS, SPECIFIC GRAVITY OF, CORRESPONDING TO  
THE DEGREES OF THE BAUME HYDROMETER.

| Degree<br>Baume. | Specific<br>Gravity. | Degree<br>Baume. | Specific<br>Gravity. | Degree<br>Baume. | Specific<br>Gravity. | Degree<br>Baume. | Specific<br>Gravity. |
|------------------|----------------------|------------------|----------------------|------------------|----------------------|------------------|----------------------|
| 0                | 1.000                | 19               | 1.147                | 37               | 1.337                | 55               | 1.596                |
| 1                | 1.007                | 20               | 1.157                | 38               | 1.349                | 56               | 1.615                |
| 2                | 1.014                | 21               | 1.166                | 39               | 1.361                | 57               | 1.634                |
| 3                | 1.020                | 22               | 1.176                | 40               | 1.375                | 58               | 1.653                |
| 4                | 1.028                | 23               | 1.185                | 41               | 1.388                | 59               | 1.671                |
| 5                | 1.034                | 24               | 1.195                | 42               | 1.401                | 60               | 1.690                |
| 6                | 1.041                | 25               | 1.205                | 43               | 1.414                | 61               | 1.709                |
| 7                | 1.049                | 26               | 1.215                | 44               | 1.428                | 62               | 1.729                |
| 8                | 1.057                | 27               | 1.225                | 45               | 1.442                | 63               | 1.750                |
| 9                | 1.064                | 28               | 1.235                | 46               | 1.456                | 64               | 1.771                |
| 10               | 1.072                | 29               | 1.245                | 47               | 1.470                | 65               | 1.793                |
| 11               | 1.080                | 30               | 1.256                | 48               | 1.485                | 66               | 1.815                |
| 12               | 1.088                | 31               | 1.267                | 49               | 1.500                | 67               | 1.839                |
| 13               | 1.096                | 32               | 1.278                | 50               | 1.515                | 68               | 1.864                |
| 14               | 1.104                | 33               | 1.289                | 51               | 1.531                | 69               | 1.885                |
| 15               | 1.113                | 34               | 1.300                | 52               | 1.546                | 70               | 1.909                |
| 16               | 1.121                | 35               | 1.312                | 53               | 1.562                | 71               | 1.935                |
| 17               | 1.130                | 36               | 1.324                | 54               | 1.578                | 72               | 1.960                |
| 18               | 1.138                |                  |                      |                  |                      |                  |                      |

NOTE.—The specific gravity of a solution is rapidly ascertained by floating a hydrometer in it. This instrument sinks deeper in solutions of low density than in those of high gravity, and the actual gravity is found by the level at which the liquid stands on the graduated portion when the apparatus is floating freely in it. Hydrometers of this kind are sometimes graduated so that the specific gravity is read off direct from the scale, others are graduated by Baume's method, and the reading may then be converted into the number representing the true density, by reference to the above table.

STATISTICS.—A London writer states that there are fourteen electrotype foundries in that city, whose total output is £80,000 (approximately \$400,000) yearly. In Chicago there are twenty foundries, having an estimated output of over \$500,000. Prices in the two cities do not differ materially, while the population of London is probably three times that of Chicago. On the basis of population, as compared with Chicago, London should support sixty electrotype foundries and should produce \$1,500,000 worth of electrotypes annually. It is evident that English printers do not employ electrotypes as extensively as the Americans, and one reason for this may

be found in the popularity of stereotyping. Nearly every large printing establishment operates a stereotyping plant, and it is, to a certain extent, independent of the electrotypers. In Chicago, very little job-printing is done from stereotypes. Few printers have facilities for doing their own stereotyping, and, when purchasing plates, most of them prefer to pay the extra cost for electrotypes.

**SWEATING.**—Shave the top of the base and the back of the plate so as to have clean, smooth surfaces. Do not shave the bottom of the base. Brush over the shaved surface of the base with soldering fluid, made by dissolving scraps of zinc in muriatic acid to saturation, and diluting with an equal bulk of water. After covering the surface of the base with a sheet of tinfoil, place it on an iron plate and float it in your metal-pot. When the tin begins to melt, remove the base from the metal-pot, place the electro upon it, and immediately clamp them together. The back of the electro should have been previously brushed over with the soldering fluid. The plate and base may be clamped together with an ordinary hand clamp, or more than one if the plate is large, first protecting the face of the plate by laying upon it a piece of smooth board. In this method of blocking, advantage is taken of the fact that tin fuses at a much lower temperature than stereotype or electrotype metal, and also that clean, bright metal fuses much more readily than old metal, or, strictly speaking, metal which has become oxidized. Because of this latter fact, it is important that the bottom of the base should not be shaved, as the film of oxid protects it to a considerable extent and insures the fusing of the tin before the base metal is attacked.

**THREE-COLOR BLOCKS, ELECTROTYPES OF.**—Mr. J. S. Sunderland, in "Penrose's Pictorial Annual," advises that in making electrotypes of fine-screen plates no brush should be allowed to come in contact with the molded surface. He produces a conducting surface by polishing the wax surface before molding, not merely brushing over the case with molding lead, but giving it a real polish. Dixon's and Morgan's polishing lead in equal proportions is recommended.

Cover the wax mold with a sheet of paper while trimming, and only blacklead the parts cut with the trimming knife. The result will be electrotypes equal in every respect to the originals.

**VATS, GLASS RAILS FOR.**—Electrotypers' depositing vats are usually lined with lead, which is turned over the top edges of the tank to guard against any possibility of leakage. To insulate the rods from the metal lining, a wooden rail is fitted over the top edges of the vat on top of the lead. So long as the wood remains dry, the insulation is effectual, but eventually it becomes saturated with the solution and must be removed. With an agitated solution, the life of the wood is shorter than when a quiescent solution is employed, but in either case it is only a question of time when the wooden rail will become saturated and rotten, and in this condition it becomes a conductor of the current and creates a short circuit which absorbs more or less of the energy of the current. The life of the rail may be prolonged by giving it several coats of waterproof paint, but a more cleanly and altogether more satisfactory plan is to substitute for the wooden rails strips of heavy glass about one inch in thickness. Such strips may be procured from glass dealers at small expense, and, with a couple of holes drilled and countersunk in each, to provide a means of securing them to the vat, they furnish a neat and serviceable finish for the vat and provide a reliable insulation for the rods.

#### **VERDIGRIS, TO REMOVE FROM ELECTROTYPES.**

—Acetic acid and table salt will aid in removing the objectionable spots. First dissolve the salt thoroughly in the acid. It is then ready for use. Use a nail-brush or tooth-brush to apply the wash. Do this carefully to avoid scratching the face of the plates. This wash will not remove the enamel from original copper engravings. After cleaning the plates, rub a little kerosene over them before and after use. Creosote will also be found a good remover of verdigris from copper surfaces.

**WASHING ELECTRO SHELLS.**—Backing up electro shells without washing is a very objectionable practice. Even

when washed with hot lye there is likely to be some wax remaining, which will be burned to the backing pan, rendering it uneven and making lots of trouble in finishing plates.

**WRINKLES IN SHELLS.**—Wrinkles in shells are caused by wrinkles in the molds. Unless the molds are carefully examined, they would not be noticed, but close inspection in a strong light will detect them.

**WATT.**—A watt is a current of one ampere, at a pressure of one volt; equal to 1-746 of a horse-power.

**WAX ENGRAVING.**—The term wax engraving is, in one sense, misleading, for, while wood, zinc, copper and steel engravings and etchings may be printed direct from the originals, the wax engraving, like the chalk-plate engraving, can not be utilized direct. The wax engraving is, in fact, a mold into or upon which copper or other metal must be deposited by the electrotyping process in order to obtain a printing surface. To make a wax engraving, a plate of copper or other metal is thinly coated with wax. The design which is to be reproduced as a printing-plate is then drawn through the wax upon the plate beneath. In the reproduction of wood engravings, zinc etchings, etc., by the electrotype process, a mold of the object is made by impressing it in a bed of wax. The wax mold is then suspended in the depositing bath, and the deposit formed upon it will obviously be an exact duplicate of the original. But we do not want a duplicate of the wax engraving. What we do want is a reverse. So, instead of making a mold, we hang the engraving in the solution, and deposit directly upon it. The process of making an electrotype of wax engraving from this point on is just the same as making an electrotype of any other printing surface. Previous to immersion in the bath, the spaces between the engraved lines are built up with wax. The engraving is then blackleaded, a film of copper is precipitated upon it by the iron-filings process, to increase the conductivity of the mold, and the connections adjusted. When a shell of sufficient thickness has been deposited, it is removed in the usual manner, backed up with

metal, straightened, mounted on a wood or metal base, and is then ready for the press.

**WAX-KETTLES.**—For melting beeswax or ozokerite, a steam-jacketed kettle should always be employed. Never heat by gas or fire, as there would be great danger of overheating and spoiling the composition.

**WAX MOLDS, METALIZING.**—The following methods of making the surface of wax molds conductive are recommended by Langbein, Urquhart and Watt. Take equal parts of albumen (white of egg) and a saturated solution of common salt, and apply the mixture to the mold by means of a soft brush. Then dry the surface thoroughly. Now make a strong solution of nitrate of silver and dip the mold into it for a few minutes, and dry again. Expose the mold to a strong light until it becomes quite black. The mold is then to be dipped into a saturated solution of sulphate of iron, when a layer of metallic silver will be formed, upon which a deposit of copper may be readily obtained. The mold should be rinsed when taken from the sulphate of iron solution, and connecting wire attached to it, when it may at once be placed in the depositing bath. Another method is as follows: Dissolve a piece of phosphorus in a small quantity of bisulphid of carbon. Stir in two drams of benzin and a drop or two of sulphuric ether; pour the whole into half a pint of alcohol and wash the surface of the mold with this mixture twice, allowing it to dry after each application. The silver solution is made by dissolving one dram twenty grains of nitrate of silver in a mixture of half a pint of alcohol and one dram of acetic acid. The mold is floated once with this solution and allowed to dry spontaneously. Another and simpler method of rendering the mold conductive is described as follows: Dissolve phosphorus in pure alcohol until a strong solution is obtained, and wash the mold with this mixture. The silver solution is prepared by dissolving nitrate of silver in ammonia to saturation. It is to be poured evenly over the mold and allowed to float over it for a few minutes. The solution is then poured off and the mold allowed to become partly dry, when the operation is

repeated. Spots which do not appear to take the solution readily should be wetted with it by means of a soft brush.

**WAX SHAVERS, VALUE OF.**—Most large electrotype foundries are equipped with wax-shaving machines. They are chiefly valuable when used in connection with power molding presses which are provided with indicators to register the depth of impression. The shaved case being of uniform thickness, and the proper depth of impression having been established and noted on the indicator, the operator may thereafter be guided entirely by the indicator, for, if the press is stopped each time at the same reading, the impressions will obviously be all of the same depth. A shaved case is also preferable, because the "skin" is thereby removed from the case, and, with it, all dust or dirt which may have collected thereon, or which, being in the wax, may have risen to the surface when poured in the case.

**WOODCUTS, TO PRESERVE.**—If wood is wet, oil can not enter it; if wood is oiled, water can not get in. As it is alternate cold or dampness and heat or dryness that swell and warp cuts and blocks, let every cut you care anything about be soaked in oil at the bottom—the place most affected—and the trouble will be overcome. You can then lay the cuts on cold stones or presses, or in moderately warm places, with little or no risk of injury.

**WOOD ENGRAVINGS, CLOSING CHECKS IN.**—Wood engravings, when subject to changes of temperature or atmospheric conditions, sometimes check or crack. When it is desired to make an electrotype of such an engraving, the checks, if not too large, may be closed by covering them with strips of damp blotting paper and then applying a hot building iron to the paper until it is wholly or partially dry. When the check has been closed, the mold should be made at once, before it has time to open again.

# INDEX.

---

- Acid, to ascertain percentage in solution, 161; effect of, on nickel bath, 161; effect of acid in solution, 161; hydrochloric, 161; muriatic, 161; sulphuric, 161; soldering, 162; acid gauge, 58
- Adams, J. A., 8, 16
- Agitation of bath advisable, 51; benefits of, 162; methods of, 164
- Alkalinity and acidity, 165
- Alloy, fusible, 165
- Amalgamation of zinc, 165
- Ammeter, 60, 165
- Ammonia, 166
- Ampere, 166
- Air blast for blackleading, 86
- Albert, Doctor, 69
- Anchoring plates, 146, 166
- Anode, 166; connections, 167; hooks, 167; plates, 167
- Antimony, 167
- Backer-up, the, 167; backing up press, 168
- Backing metal, 107
- Backing pan, 107
- Baths, constituents of, 35; size of depositing vat, 39; testing the solution, 40; steel, brass and nickel baths, 41, 44; brassing solution, 43; management of bath, 46; holes in shells, 48; temperature of bath, 48; cyanide, 49; agitation of bath, 51; Englehard process, 52; Dunton method, 54; Leetham apparatus, 55
- Battery, Smee, 15, 20; strength of, 18; scientific knowledge not essential, 19; positive and negative plates, 20; positive and negative poles, 20; electrode, anode, cathode, volt, ampere, watt, 20; platinizing, 22; care of battery, 24
- Beginning a job, 63
- Beveling machine, 134
- Black electrotypes, 174
- Blackleading, 16, 84, 168, 169
- Blister on shells, 169
- Blistered molds, 191
- Blocking, sectional and wood blocks, 143; rotary planer, 145; anchoring and nailing, 146, 166; warping, 147; dovetailing, 147
- Blowpipe, 138
- Blue vitriol, 35
- Body mold, 113
- Book plates, 135, 136; device for holding, 170
- Brass bath, 41, 44
- Brassplating, 170
- Brittle deposit, 171
- Bronzing solution, 171
- Brushes, cleaning, 173
- Building, wax knife and how to use it, 79; how to use building iron, 80; making electrical connection with mold, 81
- Burning, 172
- Cases, warming of, 172; handling the case, 81; thickness of, 72.
- Casting, the furnace, 105; leveling stand, 106; backing pan, 107; composition of backing metal, 107; preparing the shell for backing, 108; flattening plates, 110; electrotypers' press, 110; casting hard shells, 172; mounting, 112; metal bases, 112; body mold, 113; cooling the cast, 114; saw table, 116
- Cathode, 172
- Circuit, 172
- Cleaning, brushes, 173; cuts, 173; electrotype casts, 173; plate machine, 173

- Coating molds, 191; coating of copper, preliminary, 90  
 Coloring electrotype medallions, 174  
 Color plates, registering, 174  
 Combination blackleading machine, 87  
 Composition, molding, 67  
 Concave, 174  
 Conductors, quantity of current, 95; size of rods, 96; importance of good connections, 97  
 Conductivity, 175; of mold, 90, 91, 92; of solution, 202  
 Connections, 175; importance of good connections, 97  
 Copper, dissolved by solution, 176; scraps utilized, 176; to separate copper from water, 176; weight of copper, 177; how to assay copper solution, 203; copper sulphate, 35; copper vat, 38  
 Coppering foliage and plants, 92  
 Corrections, see *Revising*  
 Corrosion of copper-faced type, 177; to prevent corrosion, 177  
 Coulomb, 178  
 Cost of shells, 177  
 Crocus, 178  
 Current, high tension, 178; strength, 178; measuring, 178; restricting action of, 89  
 Curved electrotypes, casting, 179; expansion of curved plates, 179  
 Cutters, 130  
 Cyanide of potassium, 49  
 Davis, Daniel, 10, 13  
 Davis' Manual of Magnetism, 13  
 Deposition, rate of, 28, 180; economical deposition, 180  
 Deposit, cost per foot, 25  
 Depositing, vat, 38, 39; striking the mold, 99; holes in shell, 48, 100; causes of imperfections, 101; time required to deposit, 102  
 Discovery of electrotyping, 7, 8  
 Doctor Albert process, 69  
 Dovetailing, 147  
 Dunton's hot box, 186  
 Dunton method, 54  
 Durability of electrotype plates, 180  
 Dynamo, choosing a, 30, 180; superior to battery, 25; capacity of, 27; connections, 28; rate of deposition, 28, 29; care of, 33; current for nickel-facing, 34  
 Electrical connections with molds, 82  
 Electrical terms, meaning of, 20  
 Electromotive force, 181  
 Electrotyping in America, 181  
 Elkington & Company, 8  
 Englehard process, 52  
 Filmer, William, 8, 16  
 Finishing, tools required, 119; rough finishing, 119; low spots in plate, 122; straightening, 123; finishing half-tones, 181, 182; standard thickness of plate, 123; shaving machine, 123  
 Forms, preparation of, 64  
 Furnace, 105  
 Glass rails for vats, 207; Silvering solution for glass, 202  
 Goose-bill, see *Cutters*  
 Graphite in metallizing, 83  
 Gutta-percha molds, 182  
 Hard shells, casting, 172  
 Half-tones, and electrotypes, 184; inserted in electrotype plates, 184; molding of, 185  
 Holes in shells, 48, 100, 185  
 Horse-power, 186  
 Hot box, Dunton's, 186  
 Hot solution, remedy for, 204  
 Hydrometer, 58  
 Impression, depth of, 71, 72; taking the impression, 74  
 Instruments, measuring, 58, 188; acid gauge, 58; voltmeter and ammeter, 60; switchboard, 61  
 Inventions in electrotyping, 187  
 Iron, deposition of, 187  
 Irregular shaped objects, electrotyping of, 90  
 Jacobi, Professor, 7  
 Jordan, C. J., 7  
 Knight, Silas P., 16, 86  
 Leatham apparatus, 55  
 Leveling stand, 106; leveling, 187  
 Line gauge, 137  
 Linchholder, 129  
 Litmus paper, 188  
 Low spots in plate, how to detect, 122  
 Massachusetts Charitable Mechanic Association, 11  
 Measuring instruments, see *Instruments*  
 Medallions, coloring, 174  
 Melting point of metals, 188  
 Metal bases, 112; metal molds, Dr. Albert's, 150; electrotype metal, 188; capacity of metal pots, 189; specific gravity of metals, 189  
 Metallizing, use of graphite, 83; blackleading, 84; wet process, 86; air blast, 86; restricting action of current, 89; preliminary coating of

- copper, 90; irregular shaped objects, 91; conductivity of mold, 90, 91, 92; coppering flowers and leaves, 92
- Molding, press, 71, 75, 76, 190; improvements in, 16; composition, 67, 189, 190; blistered molds, 191; metallizing molds, 209; striking the mold, 99; gutta-percha molds, 182; Dr. Albert process, 69; preparation of mold, 69, 70; cooling cases, 70; depth of impression, 72; even thickness of cases, 72; warming cases, 73; wax kettle and table, 73; taking the impression, 74
- Molding wax, to soften, 191
- Mounting, 112, 146
- Murray, Joseph, 9
- New method of making electrotypes, 181
- Nickel-facing, 34, 192
- Nickel electrotypes, 191
- Nickel solution, 193
- Nickeltypes, 194
- Nickel bath, 41
- Ozo compound, 196
- Ozokerite, 67; to soften or harden, 196
- Patina, imitation of, 196
- Peeling, to prevent, 197
- Pinholes, 197
- Planer, rotary, for blocks, 145
- Plants and flowers, coppering, 92
- Plates, apparatus for flattening, 110
- Plating without a battery, 197
- Platinizing, 21
- Postage stamp plates, 198
- Preparation of work, 63; shaving and underlaying cuts, 64; wood cuts, 64; forms to have bearers, 65
- Press, electrotypers', 110
- Punches, revising, 138
- Rapid electrotyping, 198
- Reference list of terms, etc., 161
- Resistance, 198; resistance board, 61, 199
- Reverse electrotyping, 199
- Revising, tools, 136; revising stick, 137; punch, 138; line gauge, 137; blowpipe, 138; method of inserting corrections, 138, 139, 140; brass standards, 140; type high standards, 142
- Rough finishing, 119
- Router, 131
- Routing, see *Trimming and Routing*
- Salary, foreman's, 182
- Sawing, etc., 115, 118
- Saws, care of, 199
- Sectional blocks, 143
- Series, electrotyping in, 200
- Shaving machines, 123
- Shavers, wax, 210
- Shell, preparing for backing, 108; holes in, 48, 100, 185; time required to deposit, 102; washing shells, 207; wrinkles in, 208; cost of shells, 177
- Shootboard, 127
- Silver electrotyping, 201
- Silvering solution for glass, 202
- Sink, 104
- Smec battery, 15, 21
- Solution, hot, remedy for, 204; silvering, for glass, 202; specific gravity of, 205; how to assay copper solution, 203; conductivity of solution, 202; testing the solution, 40
- Specific gravity, of solutions, 205; how to find, 59
- Spencer, Thomas, 7
- Standards, brass, 140
- Statistics, 205
- Steel bath, 41
- Stick, revising, 137
- Sulphuric acid, 35, 161
- Sweating, 206
- Switchboard, 61
- Temperature of bath, 48
- Thickness of plate, 123
- Three-color blocks, electrotypes of, 206
- Tools for finishing, 119; revising, 136
- Trimming and routing, 127; shootboard, 127; the lineholder, 129; cutters, 130; the router, 131; book plates, 134; beveling machine, 134
- Type high standards, 142
- Vats, glass rails for, 207
- Verdigris, to remove, 207
- Voltmeter and ammeter, 60, 165
- Warping blocks, 147
- Washing shells, 207
- Watt, 208
- Wax shavers, 210; wax kettles, 73, 209; wax molds, metallizing, 200; wax engraving, 208; wax knife, its use, 79; wax table, 73
- Wet process of blackleading, 86
- Wilcox, J. W., 10
- Woodcuts, 64; to preserve, 210
- Wrinkles in shells, 208

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